In this Issue: The Fire in the Homestake Mine, Lead, So. Dakota.—The Municipal Asphalt Repair Plant of New Orleans.—Electric Sluice Gates for the Shoshone and Pathfinder Dams.

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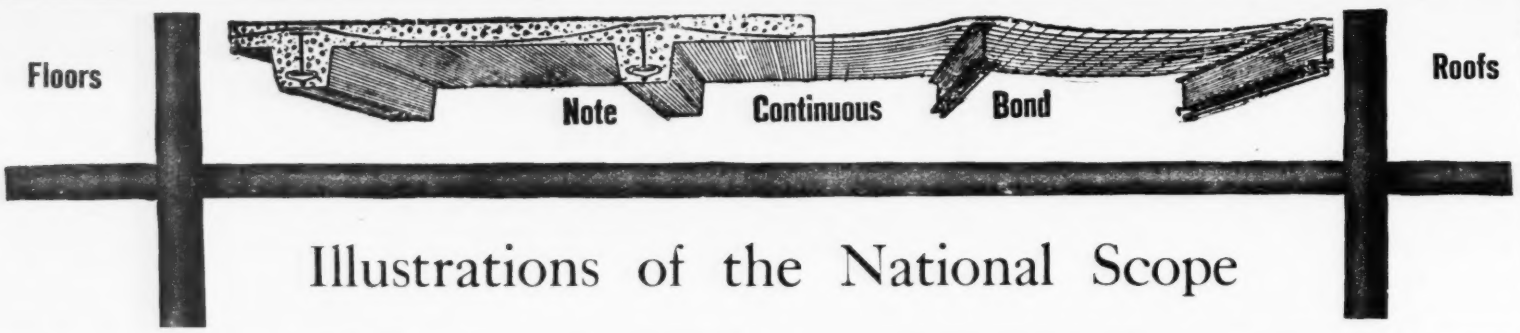

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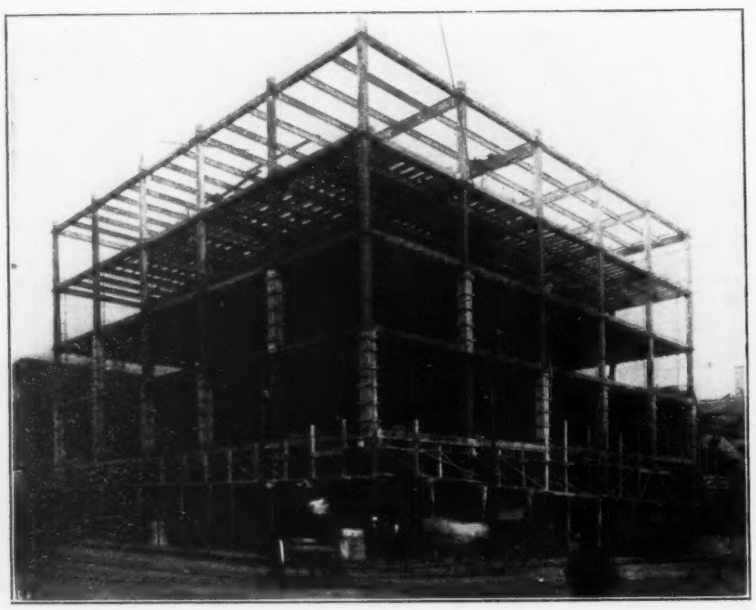

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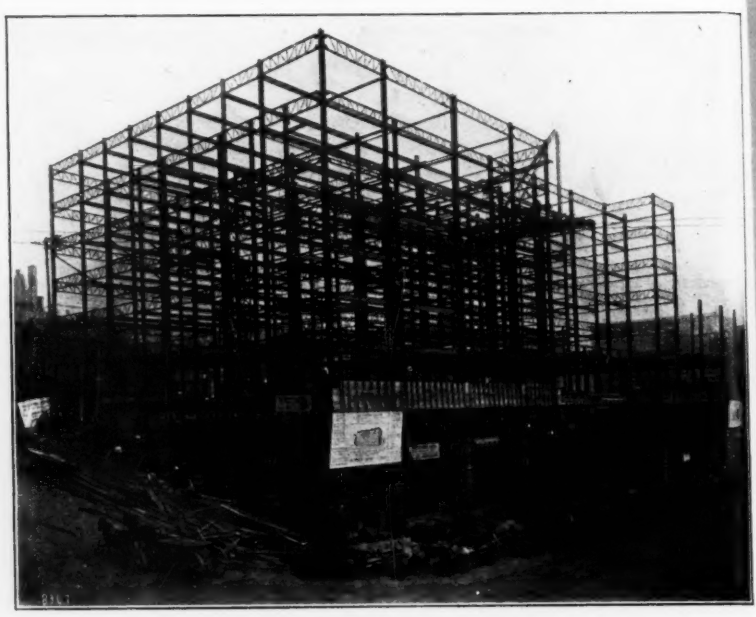

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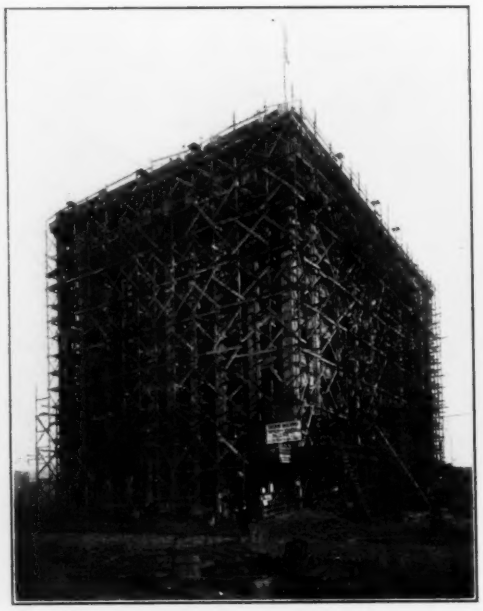

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THE HOMESTAKE MINE FIRE: UNUSUAL METHODS EMPLOYED IN FIGHTING IT, AND THE LESSONS THAT IT TAUGHT.

By BRUCE C. YATES,* M. Am. Inst. M. E.; Assoc. M. Am. Soc. C. E.

In order that the reader may more readily understand the conditions existing in the Homestake Mine, which made it necessary to flood the workings in order to put out a fire which apparently did not cover a very large area, a brief description of the ore bodies and the method of extracting the ore will be given.

The ore body of the Homestake Mine may be likened to an enormous chimney. Near the surface this chimney is very irregular, a plan of any of the upper levels showing many large "fingers" branching out from the large "palm," or main body. To some extent this holds true on the lower levels. These fingers extend much further from the main body on some levels than on others, which fact makes the "sill floor" development work vary greatly on the different levels, and sometimes gives a mistaken idea as to the amount of ore between any two levels. The fingers pitch towards the south, and the slate foot and hanging walls arching over the top produce a lens-shaped body. One of these large fingers on the 500-ft. level, called "No. 5 stope," extends about 400 ft. further south than the corresponding finger on the 400-ft. level, and is about 10 ft. high in the extreme south end, gradually increasing in height until near the north end the ore is continuous to the level above.

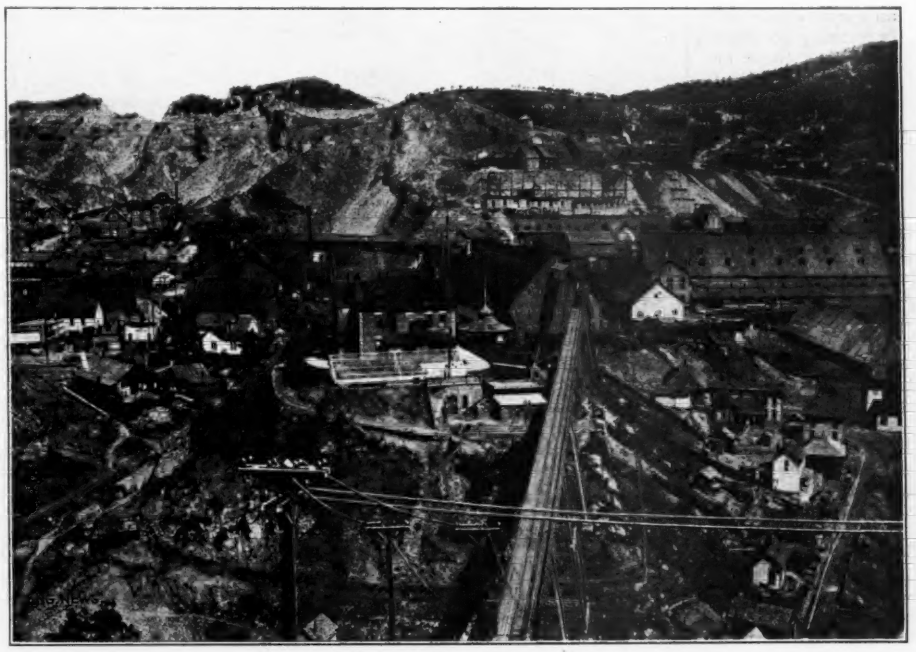
This stope was first worked during the years 1896 and 1897. At that time the "sill floor" of all stopes of whatever size was all cut out and timbered with square sets. When the stope was too large to be worked as one, above the "sill," small stopes were carried up with pillars of solid ore between them. These pillars were supported, where they had been undercut, by timber crib-work or bulkheads from 10 to 18 ft. high. The sill floor of this stope contained 1,260 sets, covering an area of 45,360 sq. ft. (the sets being 6 ft. square). Before any considerable percentage of the ore was mined the stope caved, crushing the bulkheads until they were not over 6 ft. high and in some places had the appearance of a solid piece of timber.

All the levels from the 500-ft. up were worked in this manner. Some of the stopes were filled with waste, and many more caved. In all cases the timber was left in, and the entire stope area is therefore a mass of loose rock and timber with numerous solid bulkheads built years ago to support pillars of ore while the adjacent stopes were being worked. By reference to the map reproduced in Fig. 2, and from what has been said, some idea may be obtained of the amount of timber within reach of the fire. It should be mentioned here that this method of mining has been discontinued and another method substituted whereby very little timber is used.

During the years 1900 and 1902 two small stopes were worked in one of the pillars of No. 5 stope, but both caved before they could be filled with waste. A drift, an extension of No. 4 crosscut (see map), was being opened through these caved stopes in order to reach a certain point over No. 4 stope on the 600-ft. level which was ready to be filled; and here is where the fire started.

The deepest working of the mine is the Ellison shaft, which has reached the 1,700-ft. level. More or less stoping and development work have been done on all the levels above that. There are approximately fifty miles of underground track, and the space from which ore has been removed is only a little less than 200,000,000 cu. ft. There are six regular working shafts reaching the 800-ft. level; four of these extend to the 900-ft. level, three to the 1,100-ft. level and two to the 1,250-ft. level, while the Ellison has reached a depth of 1,700 ft. All of these shafts are connected by drifts, and there are numerous air shafts and waste and ore raises connecting the different levels. Every stope has from one to four openings to the level above for ventilation, and through which waste is dumped to fill the stope when the ore has been removed.

Ventilation is good in all parts of the mine, some of the shafts being "down-cast" and some "up-cast." In fact, there are so many openings from level to level that it was not considered practicable to seal up the part of the mine where the fire was burning; and the air courses are so intricate that the gases of combustion were rapidly carried to all parts of the mine. The workings from the 500-ft. level up are connected by old raises and caved ground with the large open cut which covers the entire length of the underground workings.



GENERAL VIEW OF MILLS AND WORKS OF HOMESTAKE MINING CO. AT LEAD, SOUTH DAKOTA.

THE ORIGIN AND DISCOVERY OF THE FIRE.

The fire started sometime between 4 and 5 p. m. on March 25, 1907. Two miners were driving the drift described above and it is presumed that the timbers of the bulkhead, some of which were very dry, were set on fire by a spark from the blast or from a piece of burning fuse. It is not definitely known when the blast was fired. The miners reported that they blasted at 3 minutes after 4 o'clock, and in accordance with the rules of the company went into the drift after the smoke had cleared away to make the usual examination for any incipient fire or "missed hole." Finding everything all right, they went to the shaft and were hoisted to the surface at 4:30 p. m. It may be of interest to note that these men were old and trusted employees, having worked in the mine for more than 15 years. The fire was discovered by Henry Thomas, a watchman, shortly after 5 o'clock. On leaving the 500-ft. station of the Golden Prospect shaft, he discovered smoke coming along the foot-wall drift. By reference to the map it will be seen that the natural air currents are toward the

*Assistant Chief Engineer of the Homestake Mining Co., Lead, South Dakota.

Golden Prospect shaft from the region of the fire. The watchman at once turned in an alarm, and soon thereafter the men from all parts of the mine were called in to help fight the fire.

EARLY EFFORTS TO REACH THE FIRE WITH WATER.

The air pipes in nearly all parts of the mine are so connected with a series of water tanks located at the Ellison shaft that water may be turned into them by shutting off the air from a certain line and opening a valve in the pipe connected to a tank. In this way water may be conducted to the most distant parts of the mine in a very short time. The tanks are located on every fourth level, and are supplied with water through a 6-in. pipe from the main reservoir. The air pipe had been removed, however, from the foot-wall drift on the 500-ft. level; as the crosscuts through the stopes were constantly settling, causing the pipe to pull apart and leak. For this reason it was necessary to lay hose from the 500-ft. station of the Golden Star shaft, which was the nearest point to which water could be brought in pipes.

Two lines of hose were laid to the scene of the fire: one to the west side along the foot-wall drift into No. 4 crosscut, which was the only direct entrance to the fire; the other to the east side, by way of the main hanging-wall drift and a crosscut through Nos. 3 and 4 stopes.

It was hoped that the east line might be carried down through a winze to the top of No. 4 stope on the 600-ft. level, and thence up through a raise to the fire. This was never accomplished, as the smoke which filled the crosscut could not be driven back to the winze—although the men sprayed the crosscut with water from the hose, under a pressure of more than 200 lbs. The men who were fighting the fire in No. 4 crosscut were greatly hindered by the bursting of the hose, and were compelled to retreat several times to replace the broken hose.

As nearly all the smoke and gas came out through this crosscut, it was necessary to build a brattice so that the gas and smoke could be forced out on one side while the men worked on the other. Sixty feet of this brattice was built with considerable difficulty; it was necessary to spray the workmen constantly with water as they worked. The brattice enabled the men to check the progress of the fire until a water pipe was laid to replace the hose, which could not be trusted.

An air pipe was laid along with the water pipe. Valves and hose connections were placed in the air pipe about every third length. Each pipe line was approximately 1,000 ft. long. The laying of the air pipe was made necessary owing to the formation of carbonic acid gas, which found its way through the old stopes into the No. 1 crosscut and the foot-wall drift, and later to all parts of the mine. The gas spread so rapidly that the men were greatly hindered in the work of laying the pipe lines, and it became necessary to work them in relays of 15 minutes, each relay in charge of a foreman. When relieved, each relay proceeded at once to the shaft and was hoisted to the surface, where the men could breathe pure air until their turn came to go below.

An attempt was made to close all openings into the crosscut and the foot-wall drift. The roof and sides of the crosscut were boarded up tight with 1-in. boards and battens. In closing a tunnel the usual method was to stand 3 × 4-in. uprights, with 1-in. boards nailed on both sides, the space between being filled with wet clay. A cheaper and quicker method used in some places was to nail the boards on one side only in the manner of lap siding upside down, the ledge formed by the lap being daubed with clay to make the joint air-tight.

As the air in the Golden Star shaft (which is "up-cast," and through which the men were lowered) was charged with a considerable percentage of gas, an air lock was built near the 500-ft. station in which the men could stop for a few minutes on the way to and from the fire. This lock was made by closing a part of the drift with doors, the air inside being kept pure by the admission of compressed air. A man was stationed in this lock whose duty it was to issue a check to each man as he passed through the lock on the way to the fire, and to see that all checks were returned when the relay returned. In this way it was almost impossible for a man overcome by gas to be left behind without being missed in time to be safely rescued.

After the pipe lines were finished an attempt was made to get at close quarters with the fire. The two men at the nozzle were provided with leather helmets, which were fed with compressed air from the air main through a small hose. These helmets were made by the company's harnessmaker, and fitted up at the machine shop. With these the men succeeded in getting close to the fire, and were doing effective work when

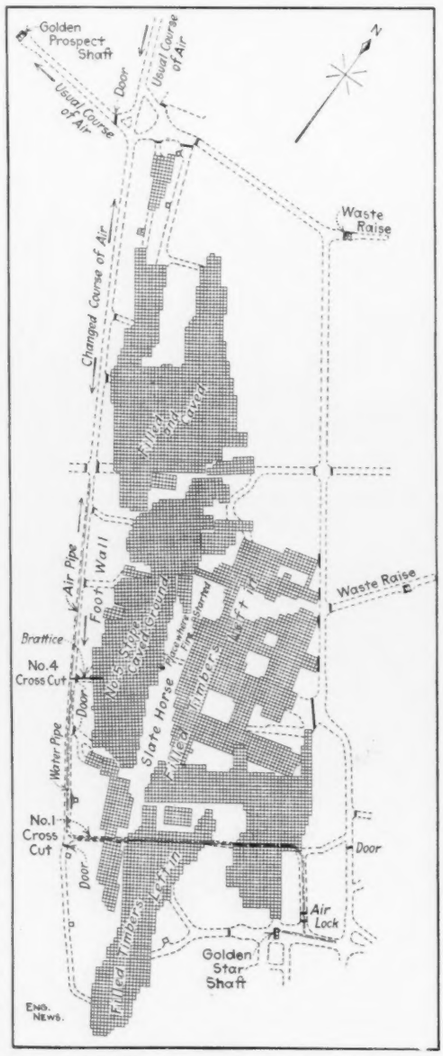


Fig. 2. Map of the Homestake Workings at the 500-Ft. Level, Showing Extent of Excavation and Where the Fire Started.

the crosscut began to cave behind them and they were forced to retreat. Soon after this the crosscut became completely filled, so that a part of the fire was entirely shut off from further access. The caving of this crosscut was no doubt caused by the fire burning out some of the timbers of the stope below, so that the water caused the fill to settle.

EFFORT TO SMOTHER THE FIRE WITH STEAM.

When it was found that the fire could not be reached with water, it was decided to close up all openings into the fire area on this level and endeavor to smother the fire by introducing steam. It was thought that the vapor might find its way through the caved drift and thus reach all parts of the fire. The openings most difficult to close were Nos. 4 and 5 crosscuts; the opening along the north side of the brattice in No. 4 crosscut was a veritable smoke flue. The greater part of one night was taken to close this opening. That part of the crosscut on the south side of the brattice was first sealed up with boards and clay, a small trap door on hinges being provided so that observation might later be made as to the effect of the steam. A narrow slot about 6 ins. wide was then sawed through the brattice boards just in front of the part already closed, and 3 × 4-in. pieces were shoved through this slot until they were tight against the further wall and one on top of another until the back of the crosscut was reached. The openings left at the top and bottom, owing to the unevenness of the rock, were then closed with bags of clay and cotton blankets. In order to accomplish this last task, a hole large enough to admit a man was cut through the brattice and covered with a trap door. A man carrying a bag of clay would pass through this door and push the clay into the opening, while a comrade would play a stream of air around his head to keep away the smoke and gas. When the No. 4 crosscut was closed, the air pipe was extended along the foot-wall drift until the next crosscut was reached; this was closed in a similar manner, as was each in turn until all were closed.

As soon as these openings were closed, a door was placed in the drift leading to the Golden Prospect shaft which turned the strong air current coming from the north down the foot-wall drift. This effectually cleared the gas from the drift so that, during the remainder of the fire fighting, men could work here for the full 8-hour shift. Closing up these openings on the 500-ft. level did not confine the gas, which found its way upward through the caved ground to the upper levels and downward through No. 4 stope to the 600-ft. level and thence to all the workings of the mine.

The steam was furnished by the regular battery of boilers at the Golden Prospect shaft. The steam pipe was connected to the air pipe at the surface, and the steam conducted down the shaft to the 500-ft. level and thence to the No. 4 crosscut through the regular air pipe. A considerable length of this pipe had to be relaid because, as has been said before, the air pipe had been removed from the foot-wall drift. No unusual difficulties were encountered in this part of the work, except that several joints of the air pipe in the shaft leaked badly when the steam was turned on and had to have new gaskets. The Golden Prospect shaft, being "upcast," carried considerable gas; and this added to the difficulty of repairing the leaky joints.

Steam was turned into No. 4 crosscut for 7½ days. It is presumed that some of the steam condensed in the pipe before it reached the end, but the pipe where it entered the door at the crosscut was hot enough to bake the clay in the joints, so that it required constant wetting to keep the joints from leaking gas.

During the 14½ days from the breaking out of the fire until the steam was turned off, the mine foreman and his assistants were making heroic efforts to keep up mining operations on the lower levels; but the gas finally drove them out of every part of the mine except the extreme north end, where a very strong current of air from the surface held the gas back. One mule on the 100-ft. level, one on the 1,000-ft. level, and two horses on the 1,250-ft. level were lost on account of the gas spreading so rapidly that they could have been rescued only at great risk to the lives of the men.

The main pump located on the 1,100-ft. level, near the Golden Star shaft, was kept going until the morning of April 2. During the previous night the engineer and his assistant attended to their duties protected by helmets. They worked in 4-hour shifts, and reported by telephone every 20 minutes so that it would be known that they were all right. About 10 a. m. on April 2, those on the surface failing to get a report at the regular time, a rescue party was sent down, who found both men nearly exhausted. They were

brought to the surface and the pumps were abandoned. From this time until it was decided to flood, the water was kept down by 500-gal. skips installed at the B. & M. shaft.

WORK OF THE HOSPITAL CORPS.

Before passing on to the further description of the fire fighting, it may be of interest to say something about the work of the hospital corps in taking care of the men overcome by gas. A temporary hospital was opened in the "change house," where one doctor was in constant attendance and sometimes two were kept busy. Restoratives and emetics, and such instruments as might be needed in an emergency, were kept handy. A mess was also established in a part of the same building, where substantial food was served at all hours, night and day.

In considering the effects of gas it is important to remember that the mouths of the principal shafts of the Homestake mine are at an average height of about a mile above sea level, so that the workings above that point at which the fire broke out are at an average elevation of 5,000 ft., corresponding to a barometric pressure of about 25 ins. of mercury. This means that the atmosphere has only five-sixths of its normal density, or, in other words, under ordinary conditions there a man takes in at a breath fully 16% less oxygen than at sea level. Any diminution of the supply of oxygen is therefore more serious than at lower altitudes.

FIG. 3. TEMPORARY PIPE LINE FROM CITY MAINS TO OPEN CUT OF HOMESTAKE MINE.

At this elevation, and at the ordinary temperature, 1 cu. ft. of dry carbonic acid gas weighs nearly 0.1 lb. The character of the gas and its effect upon the men are best given in the words of the company's chief surgeon, Dr. J. W. Freeman:

Carbon dioxide exists in the air in five to eight parts by volume in 10,000. It is the result of complete oxidation of carbon. It arises from the gradual organic decomposition of vegetable matter, fermentation, exhalations of animals, chemical decomposition and combustion of inflammable material in the presence of air. It is colorless and has a slightly sweetish odor. It is heavier than air, having a specific gravity of 1.52. On account of its weight it is slowly diffusible, but when once thoroughly mixed with air no separation subsequently takes place. When generated by combustion it becomes one of the component parts of smoke, and plays a part in asphyxiation which occurrs so often in connection with large fires.

This gas has a tendency to collect in unusual proportions in depressed localities such as old wells, pits, caves and mines. However, in this instance there were no old spots in the mine that had previously accumulated gas, as this is known to be one of the best ventilated mines in the world.

In cases of conflagration this gas, carbon monoxide, the vapors of water, and other gaseous substances, are produced and may collect in portions of a building or mine where no flame exists.

Undiluted carbon dioxide is not readily inhaled, as it has a tendency to produce a spasm of the glottis; and an immersion of the body in undiluted carbon dioxide proves rapidly fatal, as it acts as a narcotic poison. Carbon dioxide is capable of producing deleterious results upon prolonged inhalation of air containing 0.5% by volume; and 1% by volume is immediately dangerous.

The gas is absorbed through the lungs, the mucous membrane and the skin. It is eliminated by the lungs, skin, urine and bowels. It renders the arterial blood venous more rapidly than other gases. It excludes the oxygen of the air from the lungs until the blood is gradually exhausted of its oxygen, while carbon monoxide deprives the blood of its property of absorbing oxygen.

Experiments show that the heart will continue to beat for about eight minutes under complete deprivation of air, as in strangulation. This is given as an illustration that if men overcome by gas are promptly removed and attended to, there will still be time to resuscitate them.

Carbon dioxide at first causes an increased blood pressure and rapidity of the pulse; the respiration is increased, and if the gas is present in sufficient quantities becomes stertorous; sensibility is lost, and coma and death follow. As coma comes on the pulse becomes weaker and slower. The symptoms are either sudden or gradual, according to the amount of gas breathed. The smaller amount produces dizziness, loss of muscular power, a sleepy condition, and sometimes perspiration and nausea. Greater amounts of gas bring on these conditions more rapidly. There is a feeling of great weight in the head, pressure in the temples, tingling of the skin, loss of muscular power—particularly of the lower extremities—and loss of consciousness.

Some men become more accustomed to the gas than others, and could stay longer and be less affected. Many on coming to the surface, if they were not completely knocked out, would walk like a drunken man for ten or fifteen minutes. After severe or repeated exposure the men would complain of severe headache or fullness of the head, and many would be nauseated and some vomit. Others who had been completely knocked out, on coming to would act like a person coming out from the influence of an anesthetic; some would sing and shout, some give orders (an incident of this nature happened where an order was given for a large supply of pipe), others would make speeches, some wanted to fight, while others would be stupid and want to sleep.

About 9 p. m. of the day of the fire I was informed that the mine was on fire, and immediately notified the hospital staff to be in readiness to be called at any hour and as to what we would have to contend with; I had been through a similar experience 14 years ago. We were called about one o'clock the next morning.

The large "change house," being about 100 ft. from the mouth of the shaft, afforded an ideal emergency hospital, well lighted, heated and ventilated, and with plenty of hot and cold water. In this hospital we took care of something over 300 cases; and out of this number only one was sent to the Homestake hospital, and that was not really necessary.

In the treatment of these cases, fresh air is the most important agent. As soon as the first symptoms appeared the men were immediately brought to the surface, and if still breathing regularly they needed very little treatment. If respiration was suspended, artificial respiration was resorted to, and a few whiffs of aqua ammonia assisted in stimulating it. Usually two or three minutes sufficed to produce regular breathing. We were prepared to give oxygen, but in no case was it necessary. If the heart action was weak we used strychnia, nitroglycerin, or whiskey hypodermically. Spirits of ammonia, given by the mouth, acted very quickly as a stimulant.

If a great deal of nausea is present it is beneficial to empty the stomach; and usually the effect of vomiting assisted in driving the residual gas out of the lungs. As a quick emetic warm salt water, or warm mustard water, was sufficient. Sometimes it was necessary to use fluid extract of ipecac. Enveloping the head in large cloths wrung out of cold water gave relief in cases of headache, some cases of which lasted 48 hours. When the cold water gave no relief, bromides were used.

We watched for sequelae, but found there were no serious conditions following the effect of the gas. There were a few cases of bronchitis for a few days, but we attributed this more to the smoke than the gas. One case coughed blood for 24 hours. Some were unconscious for two hours, but came out all right without any serious results. There were no fatal cases during the fire, nor any since attributed to it.

The emergency hospital was established on March 26, and run night and day until April 2.

MINING RED-HOT ROCK.

An exploring party made an investigation at No. 4 crosscut soon after the steam was turned off. No fire could be seen, and the temperature inside of the door was found to be 94° F. In order to determine what the fire was doing or had done, the door and brattice in the crosscut were taken down and men were put to work to reopen the crosscut through the cave.

Before this work had progressed very far a piece of burning timber was discovered in a small drift leading north about twenty feet. Another gang of men was set to work to open this drift, with the hope of finding some part of the stope timbers still standing which would give a chance to get at the fire and discover its extent. When these drifts had been driven some twenty feet ahead the temperature began to rise, and in a short time red-hot rock was encountered in the faces of both drifts. The timber had been practically all consumed, and only occasionally would a shovelful of charcoal be found.

One large quartz boulder weighing perhaps 300 lbs., which rolled down into the drift, was so hot that after a stream of water had been playing directly on it for five minutes, it still appeared red in the center, and when broken open was almost at a white heat in the center. The work of mining red-hot rock was kept up for 13 days, during which time 1,782 carloads of rock was taken out of the two drifts, nearly all of which had to be cooled with water before it could be handled. No determinations of the rock temperatures were made, but it is safe to say that temperatures of 1,500° F. existed. The men loading the cars and timbering the drifts worked in short relays, two men loading a car and pushing it out to the main track while two fresh men would take the empty car in and load it.

Some water was constantly dripping from the backs of the drifts, which probably came from the surface, as two pipe lines and several lines of hose had previously been laid to the open cut

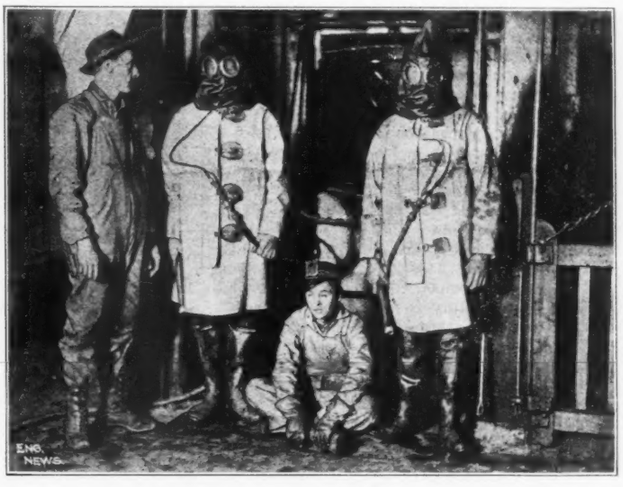


FIG. 4. MEN WITH AIR HELMETS, PREPARING TO GO DOWN ELLISON SHAFT, HOMESTAKE MINE, DURING FIRE.
(One of the tanks for air is shown on the cage, behind the men.)

just above the location of the fire, with the idea that some of the water from these might find its way down to the fire. Some of this did reach the fire, and on its way down through the warm rock was warmed until it was quite uncomfortable to the bare hand.

At times when the rock "hung up" ahead of the drift, masses of red-hot rock could be seen 12 or 15 ft. above the back of the drift. In order to cool these places a hose was fastened to the timbers, pointing toward the center of the mass; then, when all were safely away, the water was turned on. The water striking the red-hot rock would cause a great rush of steam into the drift, which would sometimes force the workmen to retreat 100 ft. or more and would break the rock and cause it to "run."

As the work of drifting seemed too slow to accomplish any good, an attempt was made to start a raise in the foot wall in order to get above the fire. This had to be abandoned, as the concussion from the blast knocked down all the doors and brattices and allowed the gas to escape into the foot-wall drift.

FLOODING THE MINE.

After these various attempts to reach and subdue the fire had failed, it was decided to flood the mine. Various predictions were made by both experienced and inexperienced mining men as to the disastrous results of this course, some claiming that the mine could not be filled, while one man of considerable prominence in the western mining region predicted the destruction of the mine by explosions when the water should reach the fire. However, those in authority on the ground, after due consideration, decided this to be the only course remaining; and on April 18 the skips, which had been used to clear the mine of water, were stopped; and the water which had previously been turned into the open cut, and the underground water, was allowed to fill the lower workings.

On the morning of April 22 the men were ordered out of the mine, and all mining operations were stopped. By this time the water had arisen on the 1,250-ft. level. The machine shop force immediately started making skips for all the hoists, and getting the hoisting engines in shape for the unwatering. Work was undertaken to secure all the available water for filling the mine, and was carried on with all possible speed. Pipes were laid from the regular mill and city mains to the open cut, and water pipes leading into the mines were opened. The quantity of water available from the regular supply when all the mills were stopped, which was April 23, was 1,280 cu. ft. per min.

One of the temporary pipe lines is shown in Fig. 3. The first part of the line is made up of short lengths of 12-in. cast-iron pipe, while further along curved pieces 4 ft. long are laid with sleeve joints caulked with oakum and lead. When all the 12-in. pipe on hand was used, a reducer was put on and the line was finished with 8-in. pipe. Fig. 5 shows water running into the open cut from this and several other pipes.

The season had been very dry up to this time, which is very unusual for the Black Hills; Whitewood Creek was flowing only about 100 cu. ft. per min.; however, snows or rains might be expected at any time, and it was decided to build a flume to carry the water of the creek into the mine through the Savage tunnel. The mouth of this tunnel is about 30 ft. lower than the 300-ft. level, and is connected with a drift on the 300-ft. level by a raise 15 ft. high, about 2,000 ft. from the mouth. This necessitated carrying the flume around the side hill over the tunnel and dropping the water through a raise, the mouth of the tunnel being closed with a timber bulkhead made of 12 × 12-in. timbers laid horizontally. It may be of interest to note that the Savage tunnel with the two raises constituted an inverted siphon. The flume was 3,200 ft. long, 36 ins. wide, and 18½ ins. deep, with a grade of 0.2%. It was built of 1½-in. native pine lumber surfaced one side and edged, sawed at the company's mill. The box was laid on 3 × 4-in. sills spaced 3 ft. centers with 3-in. × 4-in. uprights nailed to the sills and braced with 1 in. × 3 in. diagonals, nailed to the side of sill and post. The posts were tied together at the top with 1-in. × 3-in. strips. End joints had a string of marlin inserted before the boards were butted up and afterward were pitched. Horizontal joints were battened with strips of building paper and a ½-in. × 2-in. strip.

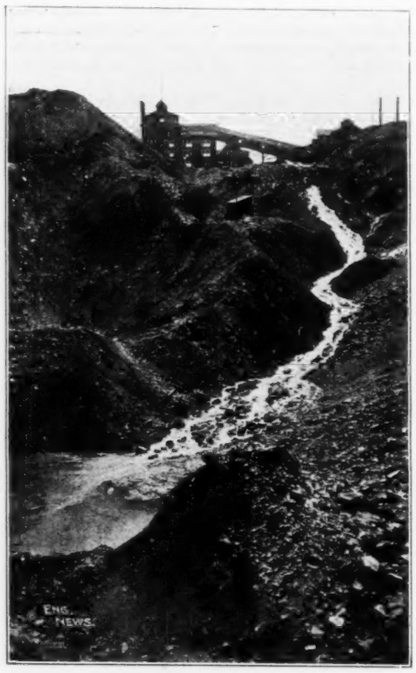


Fig. 5. View of Open Cut, Homestake Mine, Showing Water Flowing In From Temporary Pipe Lines.

The looked-for snow came before the flume was finished; and when the water was first turned in on April 30, 220 cu. ft. per min. were available. This increased until as much as 916 cu. ft. per min. were flowing. Altogether 15,912,000 cu. ft. of water were carried into the mine through this flume in 22½ days.

At the north end of the mine the 300-ft. level opens to the surface through what is known as the North End tunnel, the mouth of which is about 15 ft. above Deadwood Creek. At this point a new sinking pump which had recently been purchased was installed in a bed-rock shaft, and with it water was pumped from the creek into the mine. This pump was in operation continuously from May 5 until May 30, pumping through three 4-in. pipes and furnishing altogether 3,000,000 cu. ft. of water.

After it was decided to flood the mine, all of the shafts were boarded up at the stations, to keep out floating timber which would later interfere with the skips when the work of hoisting should begin. On account of the gas, the men were compelled to use helmets. The helmets used were sent from New York, and are said to be the same kind that are used by the fire department of that city. The tanks sent with these helmets were not large enough to furnish a sufficient quantity of air for any length of time, and it may not be out of place to say that the valves and fittings were very poorly constructed.

In order to provide sufficient air storage, two ordinary hot-water tanks, one of 66-gal. and one of 52-gal. capacity, were furnished, and provided with connections for the small hose attached to the helmets, and a pressure gage. These tanks were charged from the main air pipe to about 70 lbs. pressure and placed on the cage. When the two men were ready to go below, they would put on the helmets and turn on what air they considered necessary and they were then lowered to their work, remaining below for short periods only. On coming to the surface they would recharge the tanks. The accompanying photograph, Fig. 4, shows two men equipped with helmets and rubber suits ready to go down the shaft.

Table I. gives the time worked by two different crews of men, and the initial and final pressure as recorded by gage before going down and on coming up.

The mouths of the shafts, and all other openings through which air could reach the fire, were closed in order to keep the fire from spreading to the upper levels before the water could reach it.

When the water reached the 300-ft. level, the Golden Prospect shaft was uncovered and an exploring party went in on the 300-ft. level as close to the fire as the gas conditions would permit. By testing the air currents coming from the fire area it was found that gas was still forming; and considerable heat was manifest, although no fire could be seen. The water rising

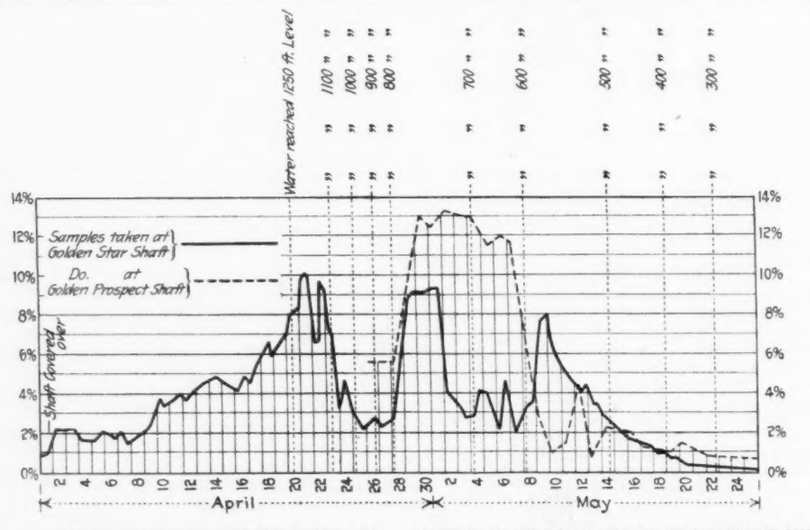


FIG. 6. CURVES SHOWING PERCENTAGES OF CARBON DIOXIDE IN AIR OF HOMESTAKE MINE DURING FIRE: SAMPLES TAKEN FROM GOLDEN STAR AND GOLDEN PROSPECT SHAFTS.

TABLE I.—TIME OF WORKING WITH COMPRESSED AIR SUPPLY.

Number of trip	Time down, minutes.	Initial pressure, lbs.	Final pressure, lbs.	Remarks.
FIRST CREW.				
1st	11	70	15	
2d	13½	70	20	
3d	9	70	37	
4th	13	70	7	
5th	12	70	..	Not recorded
6th	12	70	15	
7th	11	70	30	
8th	6	70	32	
SECOND CREW.				
1st	9	70	35	
2d	9	68	38	
3d	14	70	25	
4th	6	70	55	
5th	14	70	30	

from the level below was found to have a temperature of 120° F. at one place. After this examination it was thought best to bulkhead the Savage and North End tunnels and flood the 300-ft. level.

The bulkheads were built similarly to the one already mentioned, except that more care was exercised to make the ends of the timbers fit the sides of the tunnel. A rough hitch was first cut in the sides, and then dressed to fairly good surface with mails and stone hammers. The timbers were cut to a neat fit, and the ends as well as the longitudinal joints were caulked with oakum; short pieces of pipe provided with valves were put through the bulkheads to let the water out. The valves in the Savage tunnel bulkhead were never opened, however, as gas leaked through and fouled the tunnel so that they could not be reached. Those in the North End tunnel, being nearer the mouth, were opened, although the gas made the task difficult. Later a hole was cut through which allowed the water to flow out freely.

During the time that the water was rising on the 300-ft. level, the 200-ft. was closely watched to see whether the gas would disappear. It gradually diminished until, on May 29, less than 1% was found where 4% was present but a few days before. As the immediate vicinity of the fire was inaccessible, the status of the fire had to be determined by the presence or absence of gas. Tests were made by the chemist several times each day, and when these showed a constantly diminishing amount the conclusion was reached that the water had overtaken the fire.

ANALYSES OF THE AIR.—During the progress of the fire and the flooding of the mine some hundred of samples were taken of the air at various points, and quantitative analyses of these were made—some to ascertain whether it was dangerous to breathe, but the majority to give indications as to the probability of the continuance of combustion. In most instances it was necessary simply to estimate the percentage of carbonic acid; in others oxygen, carbonic acid and carbon monoxide were estimated by Orsat's apparatus, or the presence of carbon monoxide was tested qualitatively by means of palladium chloride.

The samples were usually taken in duplicate in dry bottles by means of a hand pump, a bicycle pump being remodeled for the purpose and fitted with a suction hose by which samples could be drawn from otherwise inaccessible places. When samples were necessarily taken hurriedly, bottles of distilled water were emptied at the desired spot; but in such cases the percentage of carbon dioxide found was always slightly too low, owing to a little being dissolved by the water.

A half-inch armored hose, such as is used to supply air drills, was lowered from the collar of the Golden Star shaft to a point somewhat below the 300-ft. level, and samples were drawn through this several times daily, a sufficient volume being pumped out to insure the entire displacement of all air contained in the hose. Other exits of the products of combustion being almost entirely shut off, a fair idea of the energy of combustion could be obtained from the samples coming from a fixed point. The variations thus observed for some weeks are shown by the curves in Fig. 6. Some of the fluctuations are due to minor causes, but in the main they correspond to conditions in the fire area.

Table II. shows typical analyses of the air.

Other samples from behind doors in the fire area yielded from 4% to 14% carbon dioxide, and showed the presence of small amounts of carbon monoxide. Water bailed during the first week of the fire was found to contain from 2.2% to 3.5% by volume of carbon dioxide. A number of samples of air taken from May 21 to May 23, near the Golden Prospect shaft on the 300-ft. level, after the water had nearly reached that level, yielded from 6.4% to 9% carbon dioxide and less than 0.1% carbon monoxide. It was impossible to breathe this air more than a few minutes without distress, and continued exposure produced headache and weakness of the knees.

There is a decided excess of nitrogen in some of the analyses quoted over the 79.2% found in normal air, which is not affected by the burning of carbon or of wood fiber to carbon dioxide (the carbon dioxide occupying the same volume as the oxygen consumed). This is due either to (1) absorption of part of the carbon dioxide by water; (2) combustion of "pitchy" wood, the excess hydrogen of which converts part of the oxygen into water; or (3) absorption of oxygen by sulphides in the rock. At times sulphur dioxide and hydrogen sulphide could be detected when moist, heated rocks were being removed from drifts in the fire area, but only traces of these were present.

The water reached an elevation of 78 ft. 8 ins. above the 300-ft. level at midnight of May 29, and was then shut off. The time required to fill the mine from the 1,550-ft. level to the point named was 39 days 17½ hours. The space to be filled was estimated at 80,000,000 cu. ft. The progress of the filling is shown by the curve in Fig. 7, which curve is carried out to show the relative time occupied in unwatering. The ordinates of the curve are the estimated cu. ft. of space to be filled.

TABLE II.—ANALYSES OF AIR IN HOMESTAKE MINE DURING FIRE.

Time and place.	Carbon dioxide.	Carbon monoxide.	Oxygen.	Nitrogen by difference.
April 2d, 500-ft. level, behind door, in vicinity of fire after being sealed 4 days	15.7%	present	4.25%	
April 11, Golden Star shaft (up-cast) at 300-ft. level	3.7%	trace	17.3%	
May 2, Golden Prospect shaft (up-cast); tramway level.....	13.4%	0.1%	6.4%	80.1%
June 3, 300-ft. level, south end, after flooding..	1.95%	0	18.2%	79.85%
June 24, 300-ft. level, south end, after flooding..	1.9%	0	18.3%	79.8%

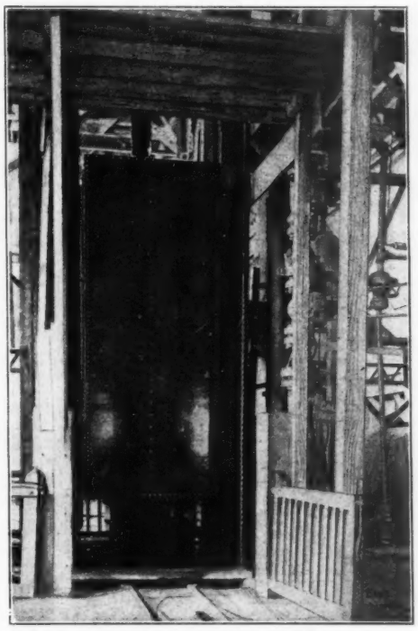


Fig. 8. One of the 2,000-Gal. Skips Used in Unwatering the Homestake Mine, at the Ellison Shaft.

UNWATERING THE MINE.

SKIPS.—The skips at the B. & M. and Golden Prospect shafts were started on May 30.*. These skips have a capacity of 1,000 gals. each, and at these two shafts the water is hoisted to the surface. At the Ellison shaft, 1,000-gal. skips, which had been built several years before, were used until the water was lowered to the 300-ft. level, when 2,000-gal. skips were installed which were dumped on the 300-ft. level. The water found its way to Whitewood Creek through the Savage tunnel, which tunnel was thus used both in filling and unwatering; 500-gal. skips were also installed at the Golden Gate shaft, and they were also dumped on the 300-ft. level, the water being carried to Deadwood Creek through the North End tunnel. The bulkheads in this and the Savage tunnels had been taken out as soon as the water was lowered sufficiently to permit its being done with safety.

All of the skips are of rectangular section with flat bottoms, and are provided with one door in the bottom which is both a discharge and an inlet; and a second door, also in the bottom, which acts as an inlet only. The discharge door has a sloping lip underneath to deflect the water from the shaft. The door is opened automatically by a trip which strikes a wooden runner fastened to the guides. These skips were all built at the company's machine shop, and were made after the decision to flood the mine was reached. The material for the large Ellison skips had to be obtained from Chicago. Fig. 8 is a photograph of one of the 2,000-gal. skips.

AIR LIFTS.—A system of air lifts was installed at the Ellison shaft, which proved to be of great assistance. Two 8-in. pipes were lowered from the 300-ft. level to the 800-ft. level in the pipe compartment, and a 2-in. pipe was put inside of each 8-in. pipe extending down about 240 ft. below the discharge. The 8-in. pipes had a conical end at the bottom, provided with 2-in. holes in the surface of the cone. The area of these holes is about 2½ times the area of the pipe cross sections. On the lower end of the 2-in.

*The text of a letter from Mr. Yates, written shortly after this date, was published in Engineering News for June 20, as a news note on p. 697.

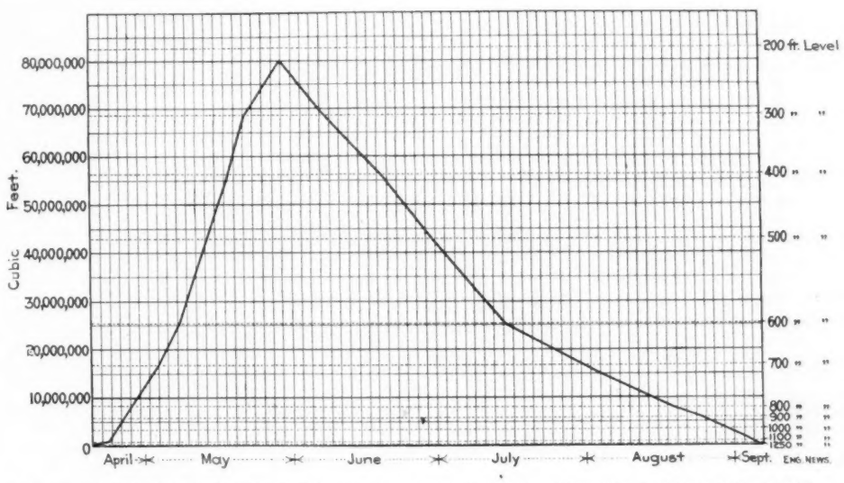


FIG. 7. CURVE SHOWING PROGRESS IN FILLING AND UNWATERING HOMESTAKE MINE.

pipe were pieces of pipe about eight inches long with numerous small holes in the circumference, pointing upward at an agle of 45°, the ends of the pipes being closed with a cap. The discharge ends of the water columns were provided with special curved elbows, having flanged openings through which the air pipes entered. Fig. 9 shows the arrangement of piping for these air lifts.

A 6-in. pipe, which is a part of the mine fire service and which connects a tank on the 200-ft. level with one on the 600-ft., was taken apart at the 300-ft. level and a 1-in. air pipe lowered inside. This pipe threw considerable water until the water was lowered 200 ft., although there were one tee and one elbow at the lower end. Both 8-in. water columns were made of screw-connected pipe, put together a length at a time and lowered by block and winch. Air at 80-lb. pressure was first used, but when the air pipes were lowered, air at a pressure of 850 lbs. was turned into one column.

When the air lifts were taken out of commission, the high-pressure line was lifting water 336 ft. with a submergence of 171 ft., and the low-pressure line was working against the same head with a submergence of 135 ft.; the two together were throwing about 600 gals. per min. When the three pipes were at their best efficiency they raised 4,397,000 gals. in 24 hours, with the water level standing 87 ft. below the discharge and a submergence of the air lines of 157 ft.

QUANTITY OF WATER HANDLED.—The total amount of water taken out of the mine by the air lifts was 83,469,000 gals. The average per day, during 31 days, was 2,692,550 gals. The total amount hoisted and pumped from the mine during this time was 309,891,500 gals., and the air lifts raised 26.9% of this. The best record for 24 hours made by all of the skips was 8,724,000 gals., and the Ellison alone hoisted 4,500,000 gals. in 24 hours from about 185 ft. below the 300-ft. level. The total amount hoisted by the skips was 540,999,000 gallons, and 18,984,000 gals. was pumped out by a Cornish pump at the B. & M. shaft, making a grand total of 643,452,000 gallons of water taken from the mine from May 30 to Sept. 6.

Figs. 10 and 11 show the water coming out of the North End and Savage tunnels respectively. As shown in the photographs, the water foamed very freely whenever agitated. Analyses of the water raised showed a marked increase in sulphates of lime and magnesia, and the presence of some iron as ferrous sulphate and carbonate. On exposure to air the iron was immediately and completely deposited as ferric hydroxide, coloring the rocks of the creeks for a long distance below the mine outlets. Much organic matter was also present.

CONDITION OF UNDERGROUND APPARATUS.—Old iron pipes and steel cars, already coated with rust, were but little affected by the submergence. Greasy metal was practically unaffected. Some new iron pipe, however, acquired a rather thick, black and slimy coating. Analyses of the entire coating scraped from a measured area of pipe showed that the iron contents corresponded to the corrosion of an average thickness of much less than 0.001 in. of metal. The deposit consisted of ferrous and ferric hydroxide, and a considerable amount of carbonaceous material, the latter apparently due to the original coating of the pipe.

Nearly all drilling machines and five compressed-air motors were left in the mine, and none of these seem to be injured to any great extent, as all were put into service again as soon as the dirt was cleaned off. Some of the small "block-holing" machines were not even cleaned, but were given a thorough oiling and put to work. The large steam pump located on the 1,100-ft. level was given a complete overhauling and was started up Oct. 7. All hollow parts of this pump were found to be filled with water, and air considerably compressed.

CONDITION OF THE MINE ITSELF.—The physical condition of the mine is excellent, considering its prolonged bath. Some of the older timbered stopes and tunnels were caved, but on the whole very little work was required to put the mine in good working condition. Some mud was deposited in the low parts of the levels as far down as the 500-ft., but the lower levels have the appearance of having been washed. This mud deposit was brought down by the water from the surface, through the open cut. Considerable loose timber had floated into the drifts and stope trackways; three or four days, however, would suffice to put a level in shape to produce ore.

The unwatering was completed to the 1,550-ft. level on Oct. 7, without mishap of any kind. Some of the mills were started on surface ore as soon as the water was turned out of the mine and became available for the mills; and as

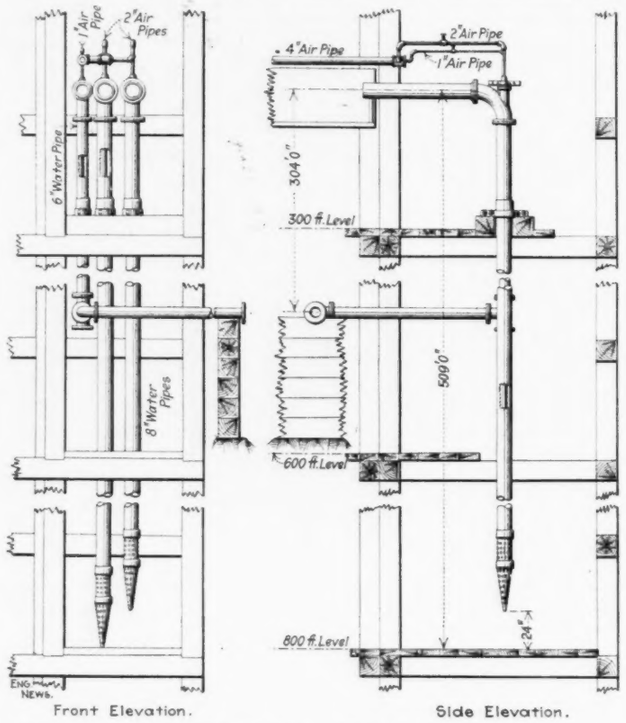


FIG. 9. ARRANGEMENT OF PIPING FOR AIR LIFTS USED IN UNWATERING THE HOMESTAKE MINE.

levels were cleared more stamps were put in operation, until on July 12 all of the 1,000 stamps were again crushing ore after a complete shut-down of 37 days.

SOME OBSERVATIONS AND LESSONS.

It was found necessary to have electric lights to work by where carbon dioxide was present in the proportion of 2% or more, and the company's electrician was kept busy during the fire-fighting period stringing wires and putting up lights to assist the fire fighters.

It was found that a man could walk at least 500 ft. in air containing 8% carbon dioxide, and remain in such an atmosphere from five to ten minutes.

By test, under conditions as found in the mine, candles and lanterns will burn in air containing 3% carbon dioxide, if handled with great care, but give very little light. Experiments made in an air-tight box provided with means for burning charcoal, while circulating the enclosed air and sampling it, showed that candles and lanterns were extinguished at once when from 3% to 3.5% of the oxygen was converted into carbon dioxide, and were extinguished by a very slight jar at more than 2%.

An acetylene lamp continued to burn in still air containing a higher percentage of carbon dioxide than a candle would stand, but the flame became yellow and finally almost blue. At this stage it separated from the burner like a cap and was blown out by the slightest draft. Charcoal fires, even when a considerable mass was strongly glowing, ceased to glow when the carbon dioxide rose to about 7%. The fact that over 15% was found behind some of the doors in the fire area is probably due to the effect of the rocks, already strongly heated and thus favoring the combustion of charred timbers in contact with them.

Some 16-c.p. electric light globes were found unbroken down as far as the 900-ft. level, having withstood a pressue of 293 lbs.

Too much care cannot be exercised to *prevent* fires in a mine when timber is used, and all rules that aim for prevention should be very strictly enforced.

A good system of water pipes, maintained even in the old, worked-out parts of a mine, is essential. A small company of men, who are familiar with all parts of the mine and with all water pipes and hydrants, and who could be drilled once a month, might do good service at the beginning of a fire. There should be one such company for each shift, and the regular drill should never be omitted. Upon these men should fall the duty of seeing that all fire-fighting apparatus is in good working order.

Helmets such as are made for rescue service are not trustworthy, and are good only for short periods of time. As built, they are too cumbersome and hinder the vision of the wearer.

Finally, the greatest lesson taught by the fire is, as has been said by a celebrated humorist, "It is better not to know so much than to know so much that ain't so."

In the preparation of this paper I am greatly indebted for much valuable assistance to Mr. T. J. Grier, Superintendent; Mr. Richard Blackstone, Chief Engineer; Mr. J. A. Spargo, Master Mechanic; Mr. W. J. Sharwood, Chemist; and to Mr. E. F. Irwin, Company Timekeeper, who kept a complete diary during the fire.

THE MUNICIPAL ASPHALT PAVEMENT REPAIR-PLANT AT NEW ORLEANS.

Within the past few years a goodly number of cities have established plants for repairing asphalt pavements. The first city to do this in the United States, if we are correctly informed, was Indianapolis. This was followed by a plant at Detroit, used for both construction and repairs. As early as 1899, the city of Winnipeg, Man., also built an asphalt construction plant (see Eng. News, April 11, 1901). In 1901, Geneva, N. Y., established an asphalt and tar macadam plant (see Eng. News, Nov. 20, 1902). Since the dates named, a number of other cities have built asphalt plants, mostly for repair rather than for new construction. Among the repair plants mention may be made of those at Columbus and Dayton, O.

The first year's work of the paving repair plant at New Orleans, La., which is also used somewhat for new construction, is described in some detail in a report just issued by Mr. W. J. Hardee, M. Am. Soc. C. E., City Engineer of New Orleans. The report covers the period ending Aug. 31, 1907, and from it we have taken the following information.

The first asphalt pavement in New Orleans was completed on Dec. 31, 1884. This pavement, like others constructed during the next three years, was laid under a 20-year guarantee contract. A

part of the asphalt pavement laid in 1887 was constructed under a 5-year guarantee, and since that time a like guarantee period has been the rule. The total amount of asphalt pavement in New Orleans on which the guarantee period had expired up to July 20, 1907, was about 550,000 sq. yds., of which 400,000 sq. yds. has to be maintained by the city and 150,000 by the New Orleans Railway & Light Co.

When it was decided to install a municipal asphalt repair plant, in 1905, the repair work on asphalt for some years previous had been badly neglected. Prior to deciding in favor of a municipal plant, the city invited bids for repair work for a period of three years. Two bids were received; the lowest of these called for $114,500 for repairs during the first year and $40,000 for repairs during each of the two succeeding years. The high figure for the first year, Mr. Hardee states, illustrates the condition in which the asphalt pavements were at that time. The total area to which the first year's contract would have applied was 297,226 sq. yds., making the average price under the bid 38.5 cts. per sq. yd. for the whole area to be kept under repair.

The specifications for the city asphalt-repair plant were quite general in character, leaving the design to the successful bidder. The specifications provided that the plant was to be operated with coal as fuel; that it should have a capacity, per day of 10 hours, of not less than 1,000 sq. yds. of 1½-in. binder and 1,000 sq. yds. of 2-in. wearing surface, each after compression on the street; that there should be two 6,000-gal. steel oil-storage tanks, with pipe connections, and also a boiler, engine, pumps, air compressor, and other apparatus, of size and number to be designated by the contractor. The contract was awarded on Dec. 5, 1905, to the Warren Bros. Asphalt Paving Co., for $16,700. This, as will be seen by figures given later, was but a start toward the necessary equipment.

The repair plant covers an area of about 1,500 sq. ft. of land already owned by the city. The buildings are of a fairly substantial character. The boiler and engine are of 35 HP. each; the air compressor has a capacity of 50 ft. of free air per minute. Besides the oil tanks already mentioned there are three asphalt melting tanks of 5,000 gals. capacity each, a mixer, screens, various storage bins, and other apparatus. A general idea of the nature and extent of the plant, in addition to what has already been given can be gained from Table I., which consists of a summary of cost of its various parts, followed by a statement of equipment costs, including live stock, etc.

After the plant was built, equipment for other street work, costing a total of $4,704, was bought, making the total capital outlay $70,713. The additional equipment included a 7-ton steam road roller, a road grading machine, sprinkling wagon, wheel scrapers and additional live stock.

The contracts for some of the main supplies for the year covered by the report included lake

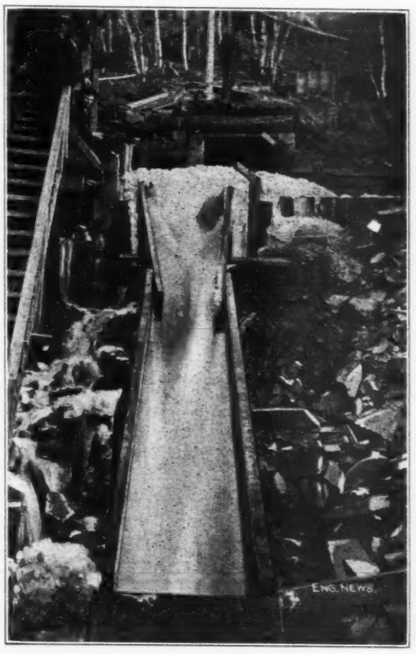


Fig. 10. Water Coming Out of North End Tunnel, Homestake Mine, Showing Foam Caused by the Gas.

shore sand at 90 cts. per cu. yd.; river sand at $1.50; pulverized limestone, $5.50 per ton; washed river gravel at $2.27 per cu. yd.; and coal at $2.75 per ton.

A number of bids for supplying the refined asphalt were received. The lowest of these was from the Union Oil Co., of California, for the Maltha brand of California refined asphalt. As described in the bid, this material was to contain no moisture at 105° C.; was to have a specific gravity of 1.055 to 1.065; was to have a bitumen solubility of 65 to 70% in Pennsylvania petroleum naphtha boiling between 80° and 90° C.; was to contain no more than 0.5 to 1% of non-bituminous organic matter; and was guaranteed to cover 100 sq. yds. (per ton?). The contract price was $18.50 per ton.

A capacious and well-equipped laboratory was established at the asphalt repair plant, using as a nucleus various laboratory equipment already provided for the city engineer. In view of the fact that testing work not pertaining to the repair plant was done at this laboratory, only a part of the laboratory charges are debited to the repair plant. These and other items of operating expense were included under special charges, as given in Table II.

General charges, including "all expenditures for the year other than those included in special charges and for materials and labor employed in repairing asphalt pavements, constructing new asphalt pavements and executing miscellaneous improvements," were as given in Table III.

Deducting the charges for new construction and for other work not pertaining to the repair of asphalt pavements, the gross operating expenses chargeable to asphalt repairs for the year ending Aug. 31, 1907, were $40,307, or an average of 11.44 cts. per sq. yd. of total pavement out of guarantee and looked after by the repair force. The price under contract, as already mentioned, would have been 11.44 cts. per sq. yd. It should be borne in mind that the cost figures given for the repairs include no allowance for interest or depreciation. It should also be remembered that there is no certainty that the same number of square yards of pavement

TABLE I.—COST OF ASPHALT REPAIR PLANT AND EQUIPMENT, NEW ORLEANS, LA.

Summary of Cost of Structures.	
Demolition of old garbage plant buildings	$475
Asphalt plant:	
Warren Bros. Asphalt Paving Co.'s contract	$16,862.50
Our alterations and additions	2,736.50
	19,599
Yard fences and gates	853
Switch tracks	1,189
Yard pavements and drains	6,721
Tower tank and filter	1,331
Water pipes and outlets	1,015
Warehouse and platform	1,471
Asphalt shed	289
Blacksmith shop and equipment	222
Stable, rolling pen and wagon shed	5,311
Stone crusher and storage bin	1,966
Yard material bins	332
Office and store-room building	5,509
Landing bins and roads	1,432
Lighting	352
General cleaning of premises	298
Total	$48,365
Summary of Cost of Equipment.	
Live stock, harness, and stable equipment	$6,198
Rolling stock and equipment	3,180
Plant tools	837
Street tools	5,402
Office furniture	447
Laboratory equipment	1,490
Total	$17,644
Recapitulation.	
Cost of structures	$48,365
Cost of equipment	17,644
Total cost of municipal repair plant	$66,009

TABLE II.—SPECIAL OPERATING CHARGES, NEW ORLEANS ASPHALT REPAIR PLANT.

One-half chemist's salary for year	$720
One-half chemist's helper's salary for year	310
One-half cost of laboratory supplies	12
One-half cost of gas	4
Engineer's salary for year	1,450
Engineer's supplies	606
Fireman's salary for year	725
Coal used at plant	972
Pine wood used at plant	30
Oak wood used at plant	45
One-half day laborer's wages at plant for year	8,092
Damaged cement	100
Total	$13,066

TABLE III.—GENERAL OPERATING CHARGES, NEW ORLEANS ASPHALT REPAIR PLANT.

Annual employees' salaries	$15,674
One-half day laborer's wages at plant	8,092
Live stock feed	3,033
Electric lighting	332
Electricity for crusher	133
Water at plant	300
Water on street	163
Blacksmith's supplies	88
Office supplies	436
Stable supplies	309
Horseshoeing	495
Extra teams	1,629
Car fare and incidental expenses	571
Lost and worn-out tools	296
Lost live stock	270
Total	$31,791

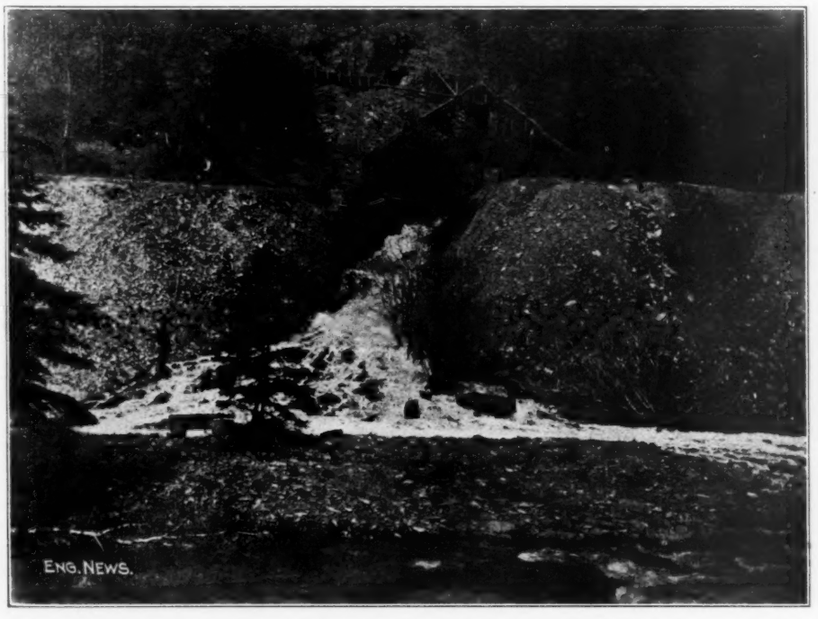


FIG. 11. WATER COMING OUT OF SAVAGE TUNNEL, HOMESTAKE MINE, SHOWING FOAM.

would have been actually repaired under contract as were repaired by the city. The total repair yardage measured up, it may be added, was 35,905 sq. yds. of wearing surface and 23,682 sq. yds. of naphtha coat. Unfortunately, the report does not state whether the specifications for doing this work by contract provide for the naphtha coat or for a binder course. It is fair to assume, however, that the specifications called for the binder course, since the specifications for the repair plant specified such a course. The naphtha coat used in place of a binder course is described in the report as follows:

"Naptha Coat" is formed of vaporized gasoline and asphalt mixed in equal proportions; it is put on the concrete foundation, when the same is perfectly dry, by hand, with brushes, just as paint would be applied, and to the least possible thickness; it is practically impervious to moisture and prevents the moisture that is commonly ever present in the concrete foundation of our pavements from attacking, through capillary attraction, the base of the asphalt "wearing surface" and rotting it; additionally, the "naphtha coat" effects a strong union of the concrete foundation and the asphalt "wearing surface" and prevents the latter from being displaced in warm weather, as is so frequently the case in old pavements in which gravel "binder" has been employed. In repairing old pavements where the combined thickness of the "binder" and "wearing surface" was considerably more than 2 ins., concrete was generally added to the original concrete foundation.

ELECTRICALLY OPERATED SLUICE GATES FOR THE SHOSHONE AND PATHFINDER DAMS.

By F. W. HANNA.*

The high-pressure gates for the Shoshone and Pathfinder dams are remarkable for the high heads under which they are to be operated and for the quantity of water that they will be called upon to control and discharge. For these reasons, the details of the gates and their operating mechanisms have been most carefully worked out. Mr. O. H. Ensign, Consulting Engineer, U. S. Reclamation Service, has done all of the designing of this most important work, and the New Jersey Foundry & Machine Co. has the contract for the manufacture and erection of the material. The group of four gates for the Pathfinder Dam has been delivered on the dam site and is now being installed. The group of three gates for the Shoshone Dam is practically completed at the shops and will soon be ready for shipment.

The Pathfinder Dam, at which the first group of gates is being installed, is situated in Wyoming, on the North Platte River, about fifty miles above Casper. [See Eng. News, Aug. 10, 1905.] It is a part of the development of the North Platte Project, the construction of which is under the supervision of Mr. Chas. E. Wells. The dam is of the circular arch semi-gravity type with an axial radius of 150 ft. It is 210 ft. high, 226 ft. long at the top and 70 ft. long at the bottom along the axis, 94 ft. wide at the bottom and 10 ft. wide at the top, having up-stream and down-stream slopes of 25 and 15%, respectively. The dam is built in an immense canyon and rests on and abuts against solid granite. The reservoir controlled by the dam will hold somewhat over 1,000,000 acre-feet of water.

The Shoshone Dam, at which the second group of gates will be installed, is situated on the Shoshone River, in a precipitous canyon about eight miles above Cody, Wyo. It is a part of the Shoshone Project, the construction of which is under the supervision of Mr. H. N. Savage. This dam is almost a duplicate of the Pathfinder, except in height, length and bottom width of the portion lying below the river bed. Its total height is 310 ft., 70 ft. of which lies below the river bed. The portion below the river bed has a width of 108 ft. and has vertical faces. The total length of the dam along the axis is 187 ft. at the top and 92 ft. at the bottom. The reservoir controlled by the dam holds about 500,000 acre-feet of water.

*Engineer, U. S. Reclamation Service, Washington, D. C.

The sluice gates are in each case to be installed in an outlet tunnel passing around the right end of the dam, through a solid granite cliff. The Pathfinder outlet tunnel is 480 ft. long, has a rectangular cross-section, with an arched roof, a width of 13 ft., a height of 9 ft. to the arch springing lines and a maximum height of 10 ft. It is located so that its bottom at the gate seats is about 194 ft. below the top of the dam. The Shoshone outlet tunnel has the same length as has the Pathfinder, but has a smaller cross-section. The cross-section is composed of a square with a side of 10 ft. topped by a segment of a circle with a radius of 10 ft. The bottom of this tunnel at the gate seats is about 233 ft. below the top of the dam.

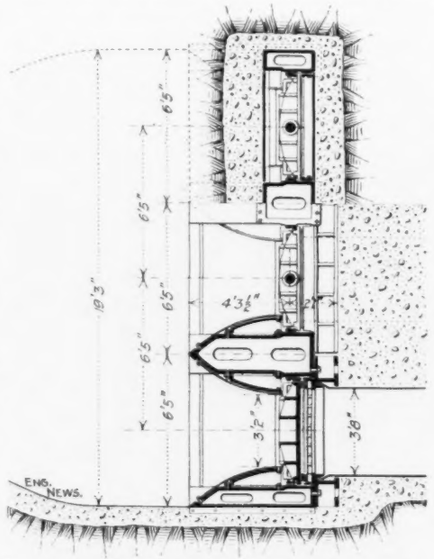


Fig. 1. Horizontal Section Through Electrically-Operated Sluice Gates, Shoshone and Pathfinder Dams.

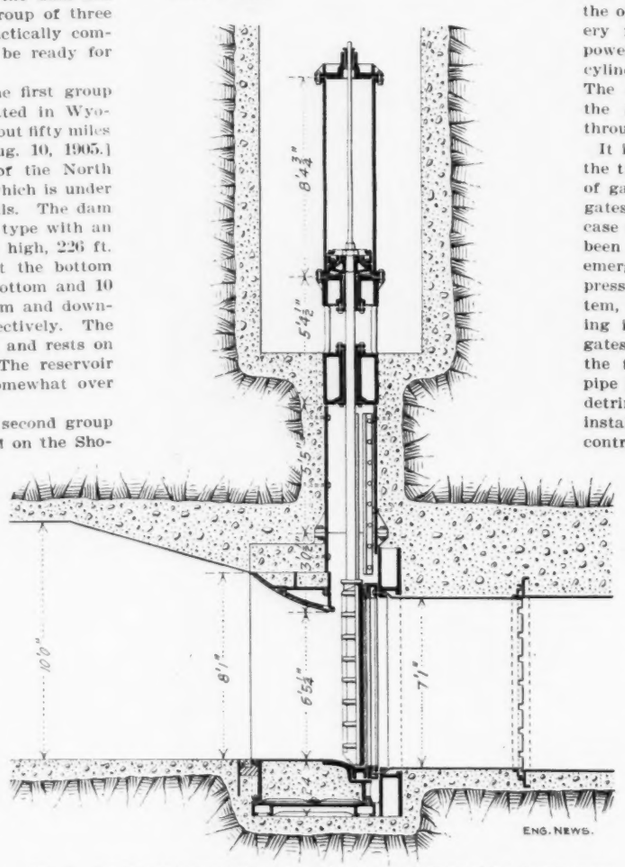


FIG. 2. VERTICAL SECTION THROUGH ELECTRICALLY-OPERATED SLUICE GATES, SHOSHONE AND PATHFINDER DAMS.

The general design of the gates used at each dam is shown by the sections, Figs. 1 and 2, and by the shop view, Fig. 3.

The Pathfinder gate chamber is located near the end of the axis of the dam at about mid-length of the tunnel. It is separated into four passage-ways by means of three concrete piers that, in conjunction with the side walls of the chamber, serve as supports for the framework of the gates. Surrounding these piers and attached to the side walls of the chamber are the massive gray iron castings forming and giving stability to the gate frames. The bed plates for the gates are continuous from wall to wall of the chamber, passing beneath the concrete piers and attaching to the partition and side-wall columns. The partition-wall columns are the heaviest castings in the structure, each weighing 12,800 lbs. The roof, floor and walls of each of the passage ways for a distance of about 4 ft. above and 6 ft. below the gate seat are lined with ½-in. steel plates for the purpose of protection from erosion. The minimum cross-sectional area of the passage-ways is about 65% of that of the tunnel proper. All bolts used in the gate chamber that are exposed to the action of the water are made of Parsons' manganese bronze, all other bolts of medium steel. Directly above each gate is a recess into which it rises on being opened. The Shoshone gate chamber is practically the same as the Pathfinder, except as affected by the number of gates. It is located below the dam, near the discharge end of the tunnel. The minimum cross-sectional area of the passage ways of this gate chamber is about 55% of that of the tunnel.

Immediately above the gate recesses and separated therefrom by a 24-in. concrete floor, is a chamber excavated in the solid rock, which in the Pathfinder scheme contains the operating cylinders and in the Shoshone contains additionally the operating machinery. The operating machinery for the Pathfinder gates is located in a power-house directly above and connected to the cylinder chamber by means of a vertical shaft. The combined cylinder and power chamber for the Shoshone gates is reached from an adit through the side of the cliff below the dam.

It is intended at some future date to install in the tunnel below the gates herein described a set of gates to act as service gates, after which the gates now being installed will be used only in case of emergency, for which purpose they have been designed. To facilitate the opening of the emergency gates by equalization of hydrostatic pressure, there has been provided a by-pass system, consisting of an 18-in. cast-iron pipe heading in the gate chamber above the emergency gates and discharging into the chamber between the two sets of gates. The upper end of the pipe is screened to prevent the entrance of debris detrimental to the system. In the Pathfinder installation there are two hand-operated valves controlling this system, one located in the cylinder chamber, the other in the power-house. Owing to the combination of the cylinder chamber and power-house in the Shoshone scheme only one such valve is needed. Drain pipes are being installed in the Pathfinder and Shoshone outlet tunnels, leading from the cylinder chambers along the tops of the tunnels beneath the concrete lining to the outlet thereof. Similar drain pipes are being placed to provide for the drainage of the future service gate chambers.

All of the gates required for both of the dams are exactly alike and are made of gray cast iron. The body of each gate is 7½ ft. long and 4½ ft. wide, closing a waterway of 7 ft. × 3 ft. 8 ins. in section. The skin plate of each gate is 2 ins. thick and is reinforced with horizontal ribs of the same thickness, spaced 10⅜ ins. c. to c. The horizontal ribs are approximately semi-elliptical, have a maximum depth of 9 ins., and are stiffened

by four vertical ribs of 1½-in. thickness. The contact portion of the face of the gate is covered with bronze strips to facilitate sliding on corresponding bronze surfaces attached to the gate frame. For the purpose of obtaining minimum friction and maximum wear the bronze sliding surface on the gate and that on the gate frame are made after formulas furnished by Mr. Ensign, each of a different composition. The specifications for these bronzes required that a block 2 ins. long and 1 in. wide, when sliding on a block of the opposite composition 1 in. wide and of suitable length with a velocity of 30 ft. per sec., shall stand a pressure of 3,000 lbs. per sq. in. without chattering or screaming and shall burnish under these conditions to a bright smooth finish without abrading. The materials furnished under these specifications stood the required test in a very satisfactory manner. The gates are of the end-closing type and the cast-iron bodies are faced on the lower ends with steel plates which rest on Babbitt-metal surfaces on the gate sills when the gates are closed. The total weight of each gate, including the lifting rod and piston, is estimated to be about 10,000 lbs. The total maximum stressing pressure and the maximum friction-producing pressure to which each gate for the Shoshone Dam will be subjected are respectively 350,000 and 440,000 lbs. The stressing pressure produces a maximum compressive stress in the horizontal ribs of about 4,300 lbs. per sq. in. and a maximum tensile stress in the skin plate of about 2,100 lbs. per sq. in. If the starting friction of bronze on bronze is assumed at 0.25, the total friction and gravity load for each gate would be approximately 120,000 lbs.

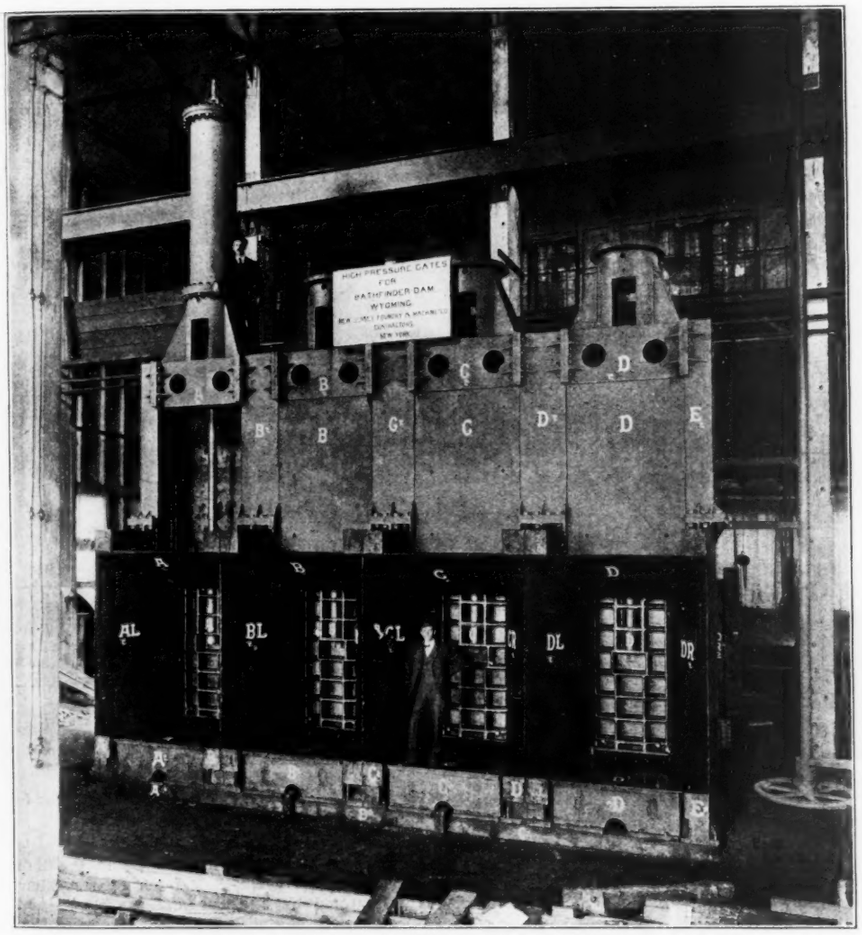


FIG. 3. SHOP VIEW OF SLUICE GATES, SHOSHONE AND PATHFINDER DAMS.

The operating mechanism, a part of which is shown by Fig. 4, consists of an oil cylinder for each gate, the piston rod of which is attached thereto, a large oil supply tank seated on the power-house floor, a pipe system connecting the oil supply tank and cylinders, a power plant consisting of a gasoline engine and a dynamo, a pumping unit consisting of an electric motor and a pump, and a small repair tank with a hand pump and hose. The oil cylinders are made of lap-welded steel with solid welded flanges and are lined throughout with brass. The steel pipe was constructed with an inside diameter of 24 ins. and was then bored to a diameter of 24⅝ ins. to receive the brass lining. The steel tubing is $^{11}/_{16}$-in. thick and the brass lining is $^{5}/_{16}$-in thick. The total brass-lined height of each cylinder is 8 ft. 4¾ ins. and the inside diameter is 24 ins. These cylinders are designed to withstand an internal pressure of 500 lbs. per sq. in., which is considerably in excess of the maximum working stress to which they will be subjected. Each cylinder piston is attached to the gate with a 5-in. lifting rod, and is made of three superimposed iron castings, between each two of which is fitted a cup leather packing. Attached to the top of the piston and extending through the top of the cylinder is a guide rod 9 ft. in length and 2 ins. in diameter. The openings in the cylinder ends for the piston rods and that through the floor of the cylinder chamber, are each provided with bronze glands to prevent leakage.

The oil supply tank is made of galvanized iron, has a capacity of 450 gals., has an indicating device showing the height of the oil, is air tight and is provided at the top with an inlet check valve set slightly above atmospheric pressure. This arrangement has been devised for the purpose of preventing the air in the oil tank from being renewed and thus permitting undue condensation of moisture therefrom.

The piping system consists of a suction for the pump connected to the supply tank, a discharge for the pump connected to the pressure pipes, an overflow pipe leading from the pump relief valve to the supply tank, the pressure pipe system providing for carrying the pump discharge to the various cylinders and for returning oil from the cylinders to the supply tank, and an overflow pipe connecting the pressure pipe system with the supply tank. In the pressure-pipe system a separate pipe leads from the top of each cylinder to the power-house room, each of which is controlled by a throttle valve. These pipes unite in the power room and are connected to the supply tank and to the pump discharge pipe, which connections are controlled by means of throttle valves. There is a single pipe leading from the power room to the cylinder chamber where it subdivides and enters the bottom of each of the cylinders. This pipe likewise connects with the supply tank and the pump-discharge pipe through throttle valves. By a proper manipulation of the throttle valves, the flow of oil through the pipes can be reversed and the pressure applied to the top or bottom of each piston. The pipes are made of extra heavy brass, are 2 ins. in outside and 1 in. in inside diameter and have been tested with an internal hydraulic pressure of 1,000 lbs. per sq. in. All connections in the system are made with ground unions and all control is obtained by means of high-pressure bronze needle valves.

To protect the pump and the piping system from sediment from the oil, the suction pipe of the pump is fitted with a strainer at its exit from the supply tank. An air chamber, consisting of 18 ft. of 2-in. pipe, is attached to the discharge pipe to equalize the flow and a relief valve set at 400 lbs. per sq. in. is placed in the overflow pipe connecting the discharge pipe and the top of the supply tank through the automatic switching device mentioned below. In case of excessive pressure, the pump is therefore capable of stopping itself. In order to protect the piping system against excessive pressure from the pump, the discharge pipe of the pump is extended beyond its connections with the pressure-pipe system to the supply tank. The overflow pipe divides shortly before reaching the top of the tank into two branches, both of which are arranged to discharge into a trip bucket near the top of the supply tank. One of these branches contains a relief valve set at a pressure of 300 lbs. per sq. in. If it is found that the starting coefficient of bronze on bronze is greater than that pro-

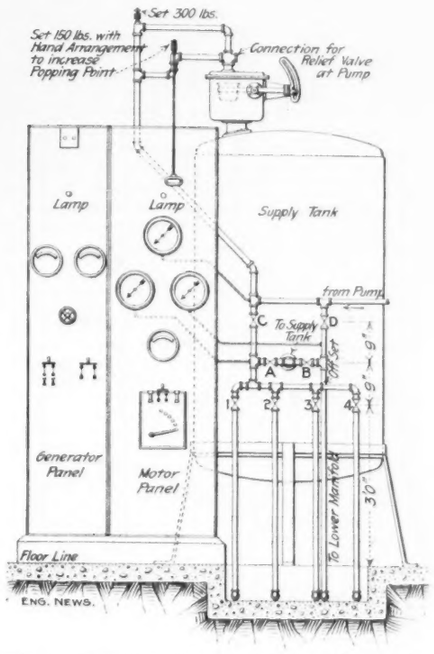


Fig. 4. Switchboard and Operating Valves for Electrically-Operated Sluice Gates, Shoshone and Pathfinder Dams.

ducing a load that can be handled by the pressure of 300 lbs. per sq. in., this value may be set at a slightly higher relieving pressure. The other branch contains a similar valve set at a pressure of 150 lbs. per sq. in. This latter valve is also equipped with a hand attachment whereby the operator may upon starting the machinery increase the pressure sufficiently to cause the gates to rise, providing this increase does not reach the intensity of 300 lbs. per sq. in., in which case the second valve will become operative. Oil will then flow through the relief pipe into a trip bucket, which upon becoming filled with oil automatically rotates about an axis, thereby breaking the electric circuit and stopping the motor. There is a small drain in the bottom of the trip bucket placed there for the purpose of permitting it to empty itself. This drain vent not only empties the bucket, and thus restores the broken electric circuit, but prevents undue breaking of the circuit for small overflows. It is thought that it will not require a pressure of over 300 lbs. per sq. in. to raise any one of the gates, unless it should for some reason become stuck. Such an intensity of pressure will provide a lifting force of about 130,000 lbs. In case any one of the gates should become stuck, the operator will raise some other gate and thereby decrease the pressure on the gate that is stuck.

In each of the pipes leading from the upper ends of the cylinders there is placed a cut-off valve, which is closed by the piston in its upward travel by coming into contact with a plunger extending from the valve down into the cylinder. By means of this automatic cut-off valve the outflow of oil is stopped just as the piston reaches the upper end of its travel, thus bringing it to rest against an oil cushion. The cylinders are thereby protected against impact from the momentum of the pistons and gates. There is also contemplated the installation of automatic gate-position indicators, electrically connected to the power-house motor panel. Although the designs have not yet been fully determined these indicators will probably be similar to those used for the gates at the Roosevelt Dam, described by the writer in Engineering News for May 30, 1907, except that the apparatus will be placed entirely outside of the cylinders and will be attached to the pistons by means of the guide rods at the tops thereof.

The 15-HP. gasoline engine used for generating power is direct-connected to a direct-current dynamo having 10-KW. capacity output and wound for 220 volts. The motor is rated at 7½ HP., is wound for 220 volts, is direct-gear connected to the pump and is equipped with a speed-controlling rheostat. The pump is of the triplex type, capable of delivering 19 gals. of oil per min. with 50 strokes under a pressure of 600 lbs. per sq. in.

The contractors are installing in each gate chamber a four-ton trolley crane, with two hoisting blocks and tackles for handling the large castings during installation. This apparatus will be left in place after erection for the removal of the cylinders and stems of the gates during repairs.

STREET GUTTER SNOW-PLOWS have been successfully used by the Street Cleaning Department of the District of Columbia. The first plow tried was supplied by the J. H. Strain Co., of New York City, for use in the winter of 1905-06. Later on, four other plows were ordered, three of which were delivered and used in 1906-07. The plow is described in the report of John Theodore Twohey, Street Cleaning Superintendent, for the year ending June 30, 1907, as follows:

> The snow-plow is a two-wheeled vehicle drawn by two horses, and having a steel blade about 18 inches in width projecting beyond the wheel into the gutter at an angle with the curb, which blade is controlled by a lever operated by the driver from his seat. The plows were assigned to the machine-sweeping territory, each being in charge of one of the inspectors on that class of work. It was found that a plow can clean the snow from approximately three miles of gutters per hour, and the machine-sweeping territory can be thus covered in about two days. The plows will not, however, remove ice, and it is necessary, therefore, that they be utilized as soon as possible after a snowfall in order to do effective work. Inasmuch as a laborer using a shovel will not clean much more than half as many miles of gutters in eight hours as a gutter plow will in one hour, it can readily be seen that a considerable saving will be effected by the adoption of the latter.

AN 845,000-LB. PLANER.*

What is believed by the builders to be the heaviest and largest metal-working planer ever built has recently been shipped from the Philadelphia works of the Niles-Bement-Pond Co. to Mackintosh, Hemphill & Co., of Pittsburg, builders of large steam engines and rolling mill machinery. The total weight of the machine is 845,000 lbs. The combined capacity of the four motors required to drive and operate this huge machine tool is 207 HP. The machine stands some 35 ft. above the shop floor. Following are some of the main outside dimensions: distance between uprights, 14 ft. 4 ins.; maximum distance from table to bottom of cross slide, 12 ft. 2 ins.; maximum stroke of table, 30 ft.; maximum stroke of slotter bar, 8 ft.; total width of bed, 13 ft.; length of bed, 60 ft.; table ways each 15 ins. in width; face of uprights, 2 ft. 6 ins.; vertical height of cross slide, including the top rib bracing, 5 ft. The motor capacity is distributed as follows: main driving motor, 100 HP.; slotting and cross planing motor, 50 HP.; lifting motor for cross slide, 20 HP.; traverse motor for heads on cross slide, 7½ HP.; air compressor motor, 30 HP.

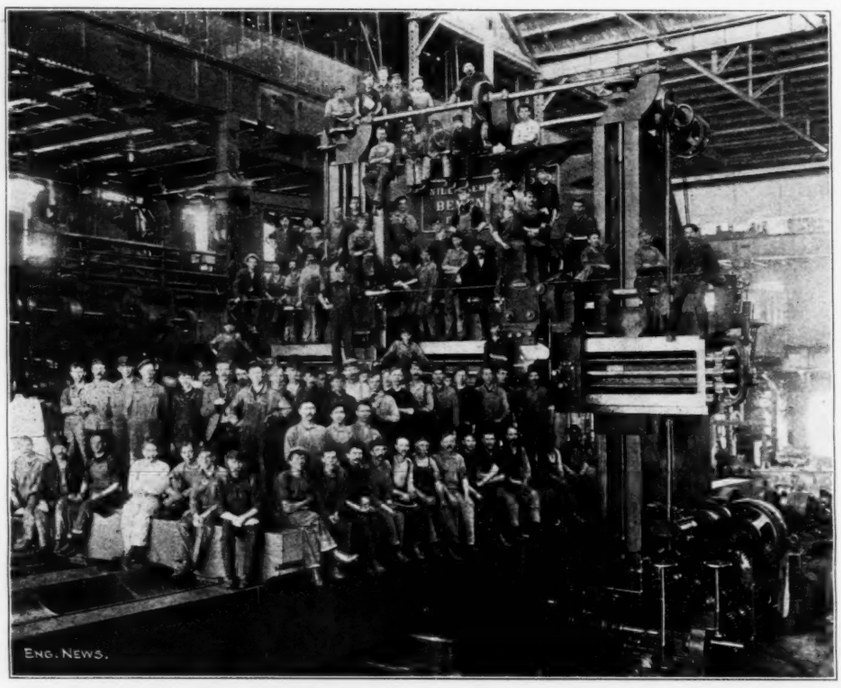


FIG. 1. THE LARGEST METAL PLANER EVER MADE.

(Built by the Niles-Bement-Pond Co., Philadelphia, Pa., for Mackintosh, Hemphill & Co., Pittsburg, Pa.)

A good idea of the actual size of this planer is shown in Fig. 1, which shows a group of 88 workmen on the machine. A better idea of the arrangement of the parts of the assembled planer is given by Fig. 2.

Several new movements have been added to the ones found on a machine of standard equipment. Each head is fitted with a slotter bar independently driven by rack, giving a cutting speed that is practically constant from one end of the stroke to the other, with a quick return. Through motor and change gears, the cutting and return speeds can be changed as desired. Each head is also arranged for transverse planing having a movement across the bed which can be varied within desired limits and which has a quick return. These movements for slotting and transverse planing make it necessary to throw out the regular driving mechanism of the table and connect it to a separate feed motion which, in this case, is entirely distinct from the regular feed motion. This throwing out of the driving mechanism, however, means simply that the pneumatic driving clutches are thrown into and left in their idle position.

The main drive from the 100-HP. motor, shown in Figs. 2 and 3, is through the gearing shown, to the pneumatic reversing clutches at the base of the upright. The speed of these clutches can be varied, to some extent, by changing the speed of the motor, and a great variation can be obtained by simply reversing two change gears. The pneumatically operated clutches are made with a large number of friction disks, so that a large friction area is obtained in a comparatively small space. A small valve controls the stopping, starting and reversing of the table and controls the use of the power from the driving motor. From this point to the table rack the drive is, in practically every respect, that which is found on any planer, except being unusually heavy and powerful.

The table drive is all of steel and the two bull pinions are forged directly on, the shaft being cut half pitch apart, in order to give smoothness of motion. The two large bull wheels working into the table rack and into the bull pinions are necessarily half pitch apart. They are connected by a sleeve and the sleeve and gears turn on the shaft, which is stationary. The shaft can be drawn out endwise, and the center bearing is capped, so that removal of the gearing is comparatively easy.

Among other new features is the pneumatic feed. The feed for the cross heads is shown in Fig. 3. On the side of the upright just above the gearing is a cylinder with piston rod extending to the left. This rod carries a rack which meshes into a gear near the bottom of the vertical feed shaft. This shaft has on its lower end a bevel gear meshing into another bevel gear on a horizontal shaft which transmits motion to the vertical feed shaft on the other upright. The movement of these feed shafts is constant at all times and variation in amount and direction of head feeds is obtained by adjusting the connecting rod in the slotted cranks on the ends of the cross slide. These cranks are graduated in such a way that definite cross and vertical feeds can be obtained, and by using at the same time the cranks on both slides an angular feed can be given to the tool, which is at times desirable, as the whole heads were not designed to swivel.

The valve for controlling the air to the feed

*Arranged from information supplied by the Niles-Bement-Pond Co., 111 Broadway, New York City.

cylinder is thrown automatically at each end of the table stroke, this movement being taken from either the main driving gear train to the table or the slotter gearing, when slotting is being done. To throw out the feed, it is merely necessary to close a valve, cutting off the air supply.

In Fig. 3 the table feed, when slotting or planing transversely, is not in position. However, it is shown in Fig. 2 directly in front of and at the base of the upright. This feed operates practically the same as the feed for the cross head, except that variation in stroke or amount of feed is obtained by an adjustable stop which regulates the amount of movement of the piston in the cylinder. This adjustment is made by the hand-wheel on the right. The left-hand hand-wheel is for connecting and disconnecting this feed mechanism to the main driving works.

In Figs. 2 and 3 can be seen a vertical shaft where the reversing hand lever of a standard planer is usually found. It will be noticed that there are two sockets at the upper end, in one of which is a handle. The upper socket is connected to a shaft which runs down to the bottom lever or crank. This is the hand-control of the slotter. The lower socket is the one that controls the movement of the table when regular planing is being done and is connected by lever and rods to the reversing dogs on the bed on both sides. Only one handle is furnished for each side, and thus mistakes arising from throwing the wrong lever are more easily avoided.

It was impracticable, both from a manufacturing and a shipping standpoint, to make either the bed or table in one piece. They were, therefore, divided to bring them within reasonable limits. The central section of the bed is divided longitudinally into three parts and the two end sections into two parts, or seven parts in all. The total weight of the bed is about 275,000 lbs.

The table is made into two sections divided longitudinally in the center and weighs about 140,000 lbs. The holes in the table for stop bolts, etc., run entirely through the upper plate, while below this is a second plate without openings extending the full width of table for catching all chips. The chips can then be removed through the side openings of the table.

The motor for fast traverse of heads is shown on the end of the cross slide in Fig. 3. The reversing is done through friction clutches. A safety device is provided which prevents throwing in the fast traverse and the feed mechanism at the same time. The motor for operating the rail is situated at the top of the upright, as shown in Figs. 2 and 3. This motor is connected at all times to the elevating screws and is stopped, started and reversed electrically.

In Fig. 2, on the end of the table, are shown small finished pads over the V-shaped and flat ways. These are to carry heads for truing up the ways when worn out of alinement. The method is as follows:

The table is raised about ¼-in. above the ways and supported in this position on sliding blocks fitting inner small auxiliary ways used only for this purpose, shown just inside of the flat outer ways. The truing heads being fastened to one end of the table, the ways are trued up from the center to the end. The heads are then placed on the opposite end of the table and the remainder of the ways finished. Near the center of the bed are pockets in the ways in which these same truing heads are placed and the table is in its turn then planed up in the same manner. The accuracy of the repair depends upon the small auxiliary ways and these are therefore finished and erected with great accuracy.

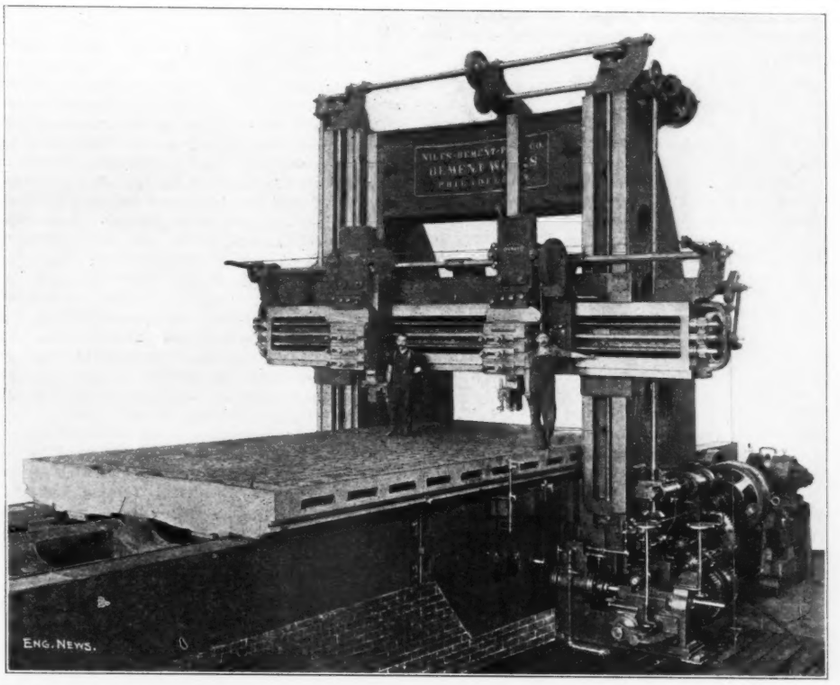


FIG. 2. FRONT VIEW OF 14-FT. BEMENT PLANER, SHOWING DRIVE AND FEED MECHANISMS, TOOL HEADS, CROSS SLIDE AND AUXILIARY WAYS.

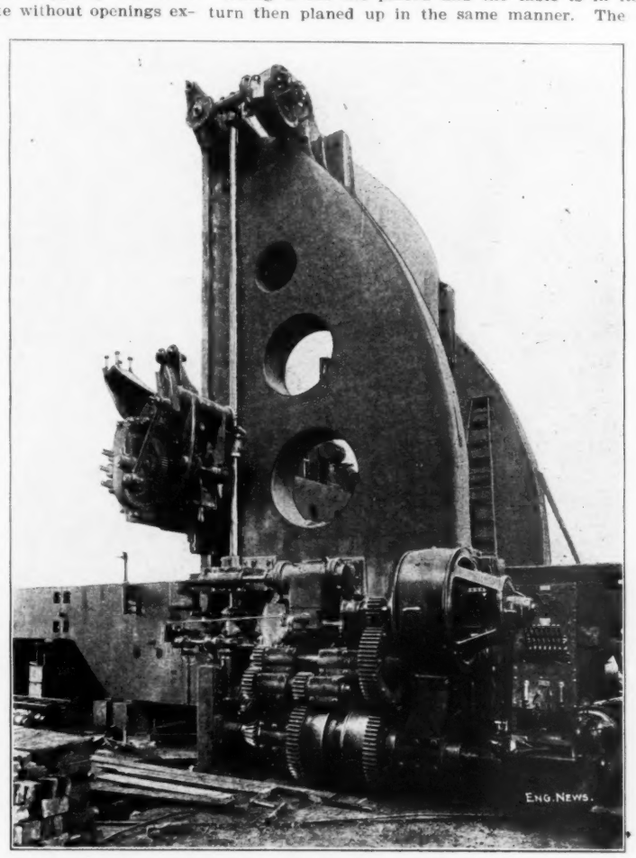


FIG. 3. SIDE VIEW OF 14-FT. BEMENT PLANER DURING ERECTION, SHOWING THE HEAVY UPRIGHTS, DRIVING MOTOR, PNEUMATIC CLUTCHES AND PORTIONS OF THE FEED MECHANISM.

THE STATISTICS OF CAR AND LOCOMOTIVE output for 1907 has recently been compiled by the "Railroad Gazette." The returns from 36 car building companies in the United States and Canada give the total number of railroad cars, including subway and elevated but excluding street and interurban cars, built by manufacturers in 1907, as 289,645, an increase of 19 per cent. over last year's record-breaking production. This does not include any cars built by railway companies in their own shops. Of this total number, 284,188 were for freight service and 5,457 for passenger, and 280,216 for domestic, and 9,429 for export service. The tabular compilation made by the "Gazette" shows the following production for the past nine years:

Year.	Freight.	Passenger.	Total.
1899	119,886	1,305	121,191
1900	115,631	1,636	117,267
1901	136,950	2,055	139,005
1902	162,599	1,948	164,547
1903	153,195	2,007	155,202
1904	60,806	2,144	62,950
1905	165,455	2,551	*168,006
1906	240,503	3,167	*243,670
1907	284,188	5,457	†289,645

*Includes Canadian output.
†Includes Canadian output of 9,159 freight and 106 passenger cars.

The locomotive statistics for the past 15 years are as follows:

Year.	No. built.	Year.	No. built.
1893	2,911	1901	3,384
1894	695	1902	4,070
1895	1,101	1903	5,152
1896	1,175	1904	3,441
1897	1,251	1905	*5,491
1898	1,875	1906	*6,952
1899	2,475	1907	†7,362
1900	3,153		

*Includes Canadian output.
†Includes Canadian output of 264.

Of the number of locomotives manufactured in 1907, 6,564 were for domestic and 798 for export use, an increase of 5 per cent. in the total domestic and of 11 per cent. in the total export. There were 330 electric locomotives and 240 compound locomotives built, as against 237 and 292 respectively last year.

Although the increase in production is marked this year, the lack of future orders in both cars and locomotives would indicate that the output for 1908 will show a decreasing rate of increase over this year, if not an actual decrease.

THE CORBETT TUNNEL, a part of the Shoshone Irrigation Project, Wyoming, has been completed by the U. S. Reclamation Service, "under force account" instead of by contract. The tunnel is 3½ miles long, 102 ft. in cross-sectional area, is lined with concrete, and has a capacity sufficient to irrigate 100,000 acres.

A NEW RECORDING ELECTRICAL VOLTMETER AND AMMETER OF GREAT SENSITIVENESS AND ACCURACY.

Accurate and very sensitive indicating electrical instruments have been in the hands of engineers, for many years, but up to the present, satisfactory forms of the more delicate recording instruments have not been made. The acquisition of such instruments depends primarily on securing an accurate, sensitive and reliable recording milli-voltmeter, for with this a line of recording pyrometers, shunt ammeters, etc., in addition, becomes possible. Obviously the familiar pen recorders are not adaptable because of lack of lightness and delicacy in the moving system and on account of friction lag and inertia of the recording pen.

The desired milli-voltmeter on which the success of the other recording instruments depends has recently been devised by Prof. Wm. H. Bristol, 45 Vesey St., New York, the inventor of the widely known Bristol recording instruments. The two most important features of the new instrument are a sensitive electrical movement of special design made by the Weston Electrical Instrument Co., and a new recording system using a patented smoked chart so arranged that there is absolutely no friction between the recording arm and the chart.

The moving system is so sensitive that the recording arm will move over the whole scale for five milli-volts, making it possible to accurately record one ten-thousandth of one volt. The graduations on the chart are evenly proportioned over the entire range, the same as on the usual Weston scales, so that readings near the minimum are as easily distinguished as those near the maximum.

The records are made on a novel semi-transparent smoked chart, which is periodically brought into momentary contact with the end of the recording arm, by means of a special vibrating device. In this way a series of white dots are made on the smoked surface. These form a continuous line and a record is thus made without causing any friction between the moving arm and the chart. The rate of vibration of the chart is timed to suit the frequency and range of the variation in the current to be recorded. The usual period of vibration of the chart is once in ten seconds, but to obtain continuous lines where the fluctuations of the current are quite rapid, the vibrating attachment is made to operate twice every second. When the record is completed the chart is dipped in a gum solution, like artists' fixative, and the record is made permanent for filing or handling.

The adaptation of this instrument for use as an ammeter is shown in Fig. 1, where it is arranged to record the voltage across a Weston standard 10,000-ampere shunt. The graduations of the record for such use show amperes directly. The use of this recording ammeter as shown does not interfere with the usual station instruments. The leads from the standard shunt may be of any desired length (provided the size of wire is such that the resistance of the leads remains negligable). This recording ammeter suggests itself immediately for the easy study of any electrically driven shop apparatus.

By the use of a suitable thermo couple with a milli-voltmeter, automatic records may be kept of any high temperature processes. In such cases the smoked charts are arranged to read the temperatures directly, subject to the same errors and approximations as are involved in any high temperature measurements.

Fig. 2 is a reproduction of a smoked chart from one of these milli-voltmeters used in connection with electrolytic surveys of underground structures by the Electrical Testing Laboratories of New York City. The graduations of this chart are arbitrary. It was revolved once in twenty-four hours and was vibrating once every ten seconds.

The zero position of the recording arm was the middle of the scale, so that the record might be independent of the direction of the current, as in many cases the direction of the current changes from negative to positive during the day.

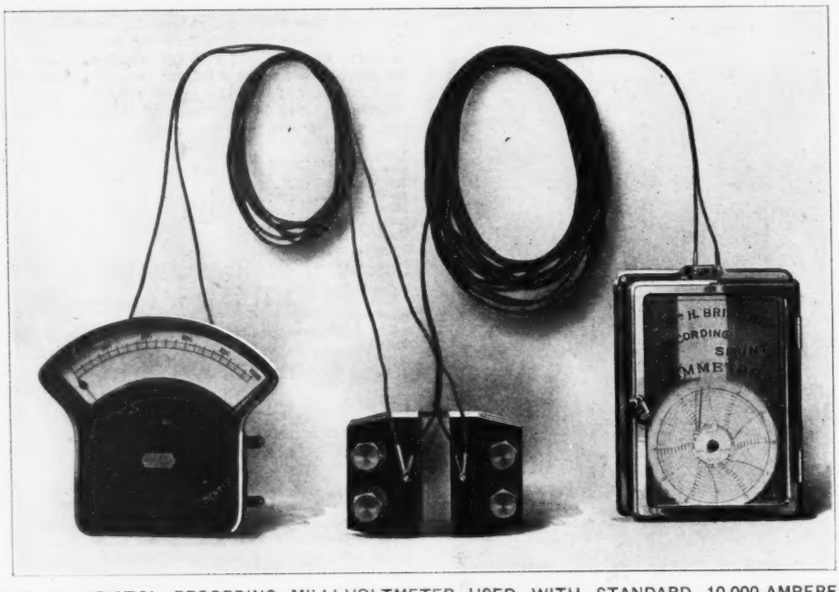


FIG. 1. BRISTOL RECORDING MILLI-VOLTMETER USED WITH STANDARD 10,000-AMPERE SHUNT OR RECORDING AMMETER. SHOWING USE IN CONNECTION WITH INDICATING AMMETER.

TAKING AN INVENTORY.

By STERLING H. BUNNELL,* M. Am. Soc. M. E.

The chief requirement of an inventory is exactness in every particular. It makes no difference in this respect whether the inventory be taken for the balancing of income and expenditure for a period of time, and the measurement of the stock on hand for the purpose of determining the exact profit or loss experienced during the interval, or whether it be an inventory of the value of the plant taken for the purpose of establishing a selling price for the whole list of materials and equipment. With this in mind, it is evident that loose methods of whatever kind are to be carefully put aside in connection with stock taking.

It was once common practice for the head of the organization to walk about his plant with paper and pencil and himself to list the articles inspected and place upon them his own valuation. Even with the smallest business this method produced gross inaccuracies. The condition of the proprietor's digestion on the days of taking inventory might well cause a 30% variation in his ideas of value on two successive inventory days.

It is hardly necessary to discuss the proposition of inventory taking by a single responsible man with discretionary powers, since the average business to-day is of such proportions that a force of men are required to cover the necessary ground, even with the quickest and best methods. The actual physical handling, weighing and counting of the stock carried in a plant employing as few as a hundred men, or in a warehouse of very ordinary dimensions, requires the assiduous application of all the men that can well be spared from the working force, and advantage must usually be taken of a holiday and of as much night work as the inventory force can stand.

The conditions under which business is carried on make it usually impossible to pass systematically from one item of stock to the next in size, and so by a regular and orderly progression through the letters of the alphabet to cover the entire plant. The use of several gangs of men working together in different parts of the stockroom or factory makes the orderly arrangement of the list impossible. The most useful system employs cards in the construction of what will later become a complete card index of all materials in stock, and which will therefore afford the usual facility of the card index, of being grouped in any desired way and totaled in any order desired. The equipment for taking inventory should therefore consist of a stock of cards sufficiently large to meet all requirements. The most useful form of card is the old-fashioned 3 × 5 library index card with a single round hole at the center near the lower edge.

Several days before commencing the inventory, the available men should be selected and called together for the purpose of instructing them in the course to be followed. A sufficient number of careful clerks should be designated, each of which should be given one or more helpers, according to the character of the material he will handle. It must be carefully impressed upon these men that in the haste of counting and recording the articles, there will be no time for forming a permanent mental impression of the condition and location of each item, and that their records must therefore be complete in every case. This will be greatly assisted by printing the cards to give places for the name of article, number of articles on hand, size, condition, place or manner in which articles were obtained (where known to the checker), and purpose for which articles are intended, where known. Above all, the weight and price are to be provided for; the weight to be taken of everything that can be weighed, as a check to the count in cases where the weight is not the basis of value. The price will naturally be filled in later, and as the assigned value will depend upon the condition and the intended purpose of the article, the description must be very carefully given as stated. The cards should be consecutively numbered, so that every card issued to the inventory force may be accounted for, preventing the loss or overlooking of any lot of articles in stock. The cards are completed by tying in strings as with the ordinary shipping tag; which can be rapidly done by office boys or other unskilled help.

Several days before the official date of the inventory, the force of men is started through the plant with instructions to commence at suitable starting points, in corners, or at ends of bins, and to progress regularly and in order from lot to lot of material, counting, weighing and inspecting each lot. The clerk of each group, being provided with a certain number of even hundreds of cards consecutively numbered, will record the data for each lot on a card, and having finished the count and satisfied himself that

*Works Manager, the Griscom-Spencer Co., 90 Wall St., New York City.

the work of his helpers is correct, will tie the card carefully to one of the pieces. This procedure being carried through as rapidly as possible, within two or three days everything in the plant will be tagged.

In the meantime the business can go on to a great extent without serious difficulty, the stock-keeper changing, by memorandum on the back of the card, the number of pieces of each lot from which he is obliged to make issue; and the workmen removing cards from pieces on which they are actually busy and replacing the cards each night, as in these cases the number of pieces will not change, but only their condition. If for any reason there are lots of parts being worked on from which one or more must be removed, extra cards may be assigned to these pieces, and the number deducted from the original card covering the lot.

On the designated date for inventory all shop-work is stopped. The count is now taken in hand by responsible men selected in accordance with the nature of the inventory being taken. If the selling price of a large works depends on the result, they will be appointed by a disinterested audit firm, or their impartiality otherwise assured. These men now proceed to the counting, each one having as many helpers as he can conveniently use. If the work of counting and recording has been well done, the inventory force has only to clip with scissors the string attaching the card to each lot, verify the condition and number and proceed as rapidly as possible through the plant. As the work up to this date has been carefully done, it will not be necessary for the inventory force to delay to count every lot of pieces, but only to count occasional lots at random, or to satisfy themselves by whatever degree of examination seems desirable, that the cards they are taking up give an accurate record of the material they are supposed to represent. While this work is going on persons not employed in taking the inventory should be excluded from the premises.

As soon as all cards are removed, the work may be resumed as before throughout the plant, and the scene of the inventory transferred to the office. It is often possible to resume work in certain departments while others are being inventoried, or to postpone the taking of cards from stock which will not be drawn upon, in case time is important. The first step in making up the record is the assorting of the cards numerically, and checking them over to make sure that none are missing. Proper care having been taken throughout the work, there should be no missing cards, and the inventory clerks can therefore be sure that everything in the plant has been counted and is on record, since two separate forces of men having gone through the works have found nothing which is not represented by its proper card.

The cards are next sorted alphabetically by kinds of material, and further arranged by sizes of material, the smallest in each case coming first, so that all are placed in the best possible order for quick pricing. By the use of current price-lists and discounts, in the case of all stock material which has full present value in comparison with new articles placed in the market, the present value of the stock on hand may be quickly ascertained. The slide rule is of great value in computing amounts and prices for this purpose, as the practical methods of weighing and measuring which are proper for such work are no more accurate than the results obtained by the slide rule in computation, and such figures are for all inventory purposes of a sufficient degree of precision.

With regard to the equipment of the plant and the fixed apparatus of all kinds, the original value is to be learned wherever possible, and an amount written off for depreciation, based on the number of years the article has been in use and its probable future life. Treated in this way the value of fixed equipment will be consistently written off from year to year, and provision will have been made for replacement of tools from the earnings of the business before the tools themselves are worn out and must go to the scrap heap. While the rate of depreciation is not properly to be discussed in connection with taking an inventory, it is well to recall to mind that the future period of use of a machine depends quite as much upon the progress of invention as on the wearing qualities of the machine itself, as the production of a better machine will terminate the useful life of the present one just as surely as its breakage beyond repair through some accident; also that the value of foundations for buildings on leased property cannot be spread over more years than the lease has to run, unless it is possible to take a gambling chance on the renewal of the lease for a further term, justified in some cases by reason of a knowledge of probabilities in this direction.

When all inventory cards have been priced and again arranged in the order of kinds of material and sizes, an adding machine may be advantageously used to foot up the totals of the various classes of material, and a summary sheet made up covering the entire plant. The result will be a complete card index of everything on hand, susceptible of being grouped in any desired way, and in the best possible order for the opening of a running inventory, if such has not been previously kept. The running inventory, while requiring necessarily a few hours each day to do the necessary clerical work of posting receipts and issues, will save its entire cost in decreasing the expense of the following inventory, as it is only necessary to check the running inventory item by item as each lot of stock runs out and is replenished by purchasing a new supply.

If it be proved by this daily checking process of nearly exhausted lots that the record is being accurately kept and that the books agree with the actual stock on hand, it is possible to dispense with the inventory entirely, and to satisfy all requirements by a simple summary taken from the pages of the running inventory upon the proper date, and a revaluation of all lots in accordance with the current market prices. The running inventory may be kept on either cards or loose leaves, one of the two being absolutely necessary in order to provide for perpetual arrangement in order, notwithstanding additions or subtractions of kinds of material kept in stock. Whichever form is used, the record is arranged to show quantity on hand, quantity received and quantity issued, and the balance is carried forward after every single issue, or in very large stocks, at the close of each group of issues or at the end of each day or week. It is thus the work of a moment to note, when stock is low, that the inventory page shows a balance on hand to correspond with the number found by actual count.

Aside from the direct purpose of the inventory many things may be learned by the actual process of taking stock, or by the careful study of the inventory record. The tendency of the stock to grow too large is the most conspicuous point which forces itself upon the observer; and with this comes recognition of the fact that the most undesirable articles, those which are unsalable or are rarely called for, are the very ones which are most certainly forgotten by salesmen or foremen who might put them to use, and which therefore are likely to lie in stock indefinitely. A careful inventory such as is here described can hardly fail to return its value many times over in the probability of the recollection and consequent disposal of a number of undesirable items, and in the avoidance by all interested of the purchase of articles when stock on hand can be substituted, or when previous conditions show that an over-stock will be further accumulation of dead matter.

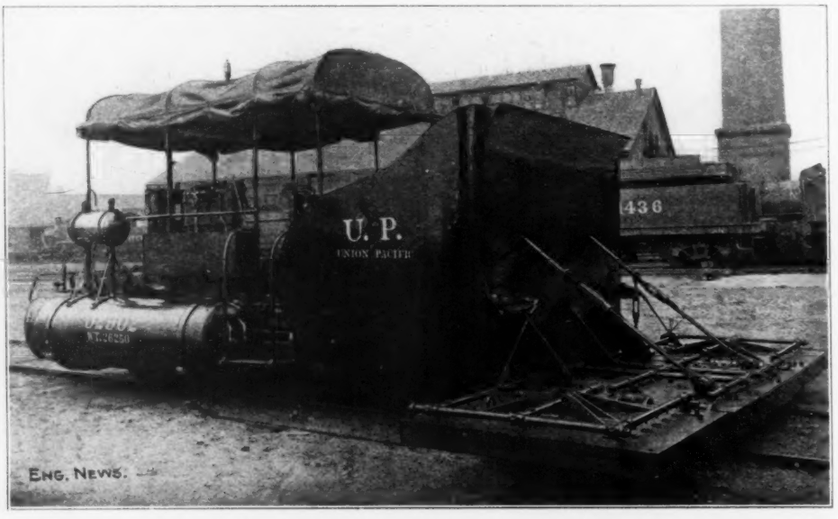
FIG. 2. SEMI-TRANSPARENTLY SMOKED CHART FOR DELICATE RECORDING INSTRUMENTS. PATENTED BY WM. H. BRISTOL, NEW YORK CITY.

A LARGE CONCRETE DAM, 50 ft. high, 400 ft. long and containing 24,000 cu. yds. of concrete, has just been completed, after four months' work, for the La Crosse Water Power Co. at Hatfield, Wis. There is to be installed at this point a 16,000-HP. electric transmission plant covering a radius of 90 miles of territory. The contractors are J. G. White & Co.

A RAILWAY WEED-BURNING MACHINE USING GASOLINE FOR FUEL.

Weed-burning machines have been successfully employed on a number of railways, especially in districts where the growth of grass and weeds is rapid, and on lines where the section forces are too limited to cope with the weeds successfully or economically. In most cases oil is used for fuel and the machine is propelled by a locomotive, but one of the latest machines is self-propelling and uses gasoline for both propulsion and weed-burning. Two of these machines have been used on the Union Pacific Ry., and one of them is shown in the accompanying cut. They were built by the Commonwealth Steel Co., of St. Louis, Mo., to which company we are indebted for photographs and information.

The machine is built entirely of steel and iron, and a single steel casting forms the underframe, with engine foundation and floor. It is mounted on two axles, and weighs 26,250 lbs. It is self-propelling, being equipped with a gasoline engine and transmission gear designed to give two speeds, the engine running normally at 350 r. p. m. The low speed is 4 mi. per hr., and is used when burning



SELF-PROPELLED WEED-BURNING MACHINE USING GASOLINE FOR FUEL AND PROPULSION: UNION PACIFIC RY.
Commonwealth Steel Co., St. Louis, Mo., Builders.

weeds. The high speed, 20 mi. per hr., is used only in going to and from work. The control of the engine is very flexible, however, and the burning may be done at any speed from 2 to 6 mi. per hr., while on the high speed the machine will run as fast as 26 or 27 mi. per hr. The self-propelling feature eliminates all locomotive service and greatly reduces operating expenses.

The fuel used is a low grade of gasoline, and the arrangement of the burners is such as to give a flame so intense that good results would probably be obtained at a speed of 5 or 6 mi. per hr. This intense heat is obtained by using large cast-iron burner frames or aprons which confine the heat and reflect it down upon the weeds. The aprons also carry a series of pipes through which the gasoline passes before reaching the burners, so that in passing through these pipes it is vaporized and delivered to the burner tips just above the frame at a very high temperature. Below each burner tip there is a tube inserted into the frame, and the gasoline in passing through this tube mixes with a proper amount of air. There are 75 of these burners carried in the three frames, thus distributing the heat evenly over a considerable area. The two outer frames or aprons are hinged so as to be swung up parallel with the rails to clear cattle-guards and bridges, or lowered to conform to the slope of the bank. The vaporizing of the gasoline in the pipes produces sufficient pressure to give a strong flame, so that only enough compressed air is needed to force the gasoline out of the fuel tanks. Each machine is provided with three tanks which carry a sufficient supply of gasoline for a day's work. The machine is capable of cleaning about 20 mi. of track per day, burning a strip 14 ft. wide.

In addition to doing this work at far less cost than it can be done by hand, it does it at the proper time, when perhaps laborers would not be available. By using this machine, also, the regular section forces can be kept at their regular work on the track through the summer months, which is the best time for this work.

Three men operate the machine: an engineman, a conductor and a helper. The controlling levers and valves are grouped within easy reach of the engineman, who is protected from the heat by a shield. The machine is equipped with air brakes and air whistle, and carries gasoline and compressed air in cylindrical tanks. It is claimed that one machine can easily keep down the weeds on 600 miles of track.

The machine makes two trips over the track, as it is found better and more economical to destroy the weeds this way. This is owing to the fact that the weeds contain a large percentage of water, and to consume them at one burning it would be necessary that the heat should be of sufficient duration to first evaporate this water and then ignite the dried-out stalk. This would make the rate of travel very slow and the fuel consumption very high per mile. If the weeds are subjected momentarily to intense heat the plant life is destroyed, making it impossible to take any more water from the ground, so that the plants die merely from lack of water. One or two days exposure will then dry them up sufficiently, so that upon the second passing of the weed-burner they are ignited and burned.

The Union Pacific Ry. used one of these machines during the past season on the Nebraska Division and one on the Kansas Division. During the early part of the year the latter machine cleaned 133 miles of track with 1,555 gals. of gasoline, or an average of less than 11.7 gals. per mile for each burning. About 20 gals. per mile, however, is a fair average for each burning. In using this machine the total cost per mile is about $2.75 for each burning, or $5.50 to totally consume the weeds. The cost is distributed about as follows:

20 gals. of 66° gasoline at 11 cts.		$2.20
Engine operator	$3.50	
Helper	2.50	
Conductor	4.00	
Oil, waste and repairs	2.50	
Total for 25 miles	$12.50	
Ave. per mile		.50
Ave. per mile for each trip (including fuel)		$2.70
Ave. per mile for two trips* (including fuel)		5.40

*Two trips are required for effective and economical work, as stated in the article.

SPECIFICATIONS FOR A FLYING MACHINE.

Press reports for some time past have intimated that a "heavier-than-air" flying machine had been authorized by the War Department. Specifications have been prepared by Brigadier Gen. James Allen, Chief Signal Officer, and Maj. G. O. Squier, Signal Corps, U. S. A. Their specifications were published Dec. 23, and are reprinted below. It will be noted that the machine in question is in no sense a dirigible balloon.

ADVERTISEMENT AND SPECIFICATION FOR A "HEAVIER-THAN-AIR" FLYING MACHINE.

ANNOUNCEMENT.

Sealed proposals, in duplicate, will be received at the Signal Office, U. S. A., until 12 o'clock, noon, on Feb. 1, 1908, on behalf of the Board of Ordnance and Fortification for furnishing the Signal Corps with a "heavier-than-air" flying machine. All proposals received will be turned over to the Board of Ordnance and Fortification at its first meeting after February 1, for its official action.

Persons wishing to submit proposals under this specification can obtain the necessary forms and envelopes by application to the Chief Signal Officer, United States Army, War Department, Washington, D. C. The United States reserves the right to reject any and all proposals. Unless the bidders are also the manufacturers of the flying machine they must state the name and place of the maker.

PRELIMINARY.—This specification covers the construction of a flying machine supported entirely by the dynamic reaction of the atmosphere and having no gas bag.

ACCEPTANCE.—The flying machine will be accepted only after a successful trial flight during which it will comply with all requirements of this specification. No payments on account will be made until after the trial flight and acceptance.

INSPECTION.—The government reserves the right to inspect any and all processes of manufacture.

GENERAL REQUIREMENTS.

The general dimensions of the flying machine will be determined by the manufacturer, subject to the following conditions:

(1) Bidders must submit with their proposals the following:

(a) Drawings to scale showing the general dimensions and shape of the flying machine which they propose to build under this specification;

(b) Statement of the speed for which it is designed;

(c) Statement of the total surface area of the supporting planes;

(d) Statement of the total weight;

(e) Description of the engine which will be used for motive power;

(f) The material of which the frame, planes and propellers will be constructed. Plans received will not be shown to other bidders.

(2) It is desirable that the flying machine should be designed so that it may be quickly and easily assembled and taken apart and packed for transportation in army wagons. It should be capable of being assembled and put in operating condition in about one hour.

(3) The flying machine must be designed to carry two persons having a combined weight of about 350 lbs., also sufficient fuel for a flight of 125 miles.

(4) The flying machine should be designed to have a speed of at least 40 mi. per hr. in still air, but bidders must submit quotations in their proposals for cost depending upon the speed attained during the trial flight, according to the following scale:

40 mi. per hr.	100%
39 mi. per hr.	90%
38 mi. per hr.	80%
37 mi. per hr.	70%
36 mi. per hr.	60%
Less than 36 mi. per hr., rejected.	
41 mi. per hr.	110%
42 mi. per hr.	120%
43 mi. per hr.	130%
44 mi. per hr.	140%

(5) The speed accomplished during the trial flight will be determined by taking an average of the time over a measured course of more than five miles, against and with the wind. The time will be taken by a flying start, passing the starting point at full speed at both ends of the course. This test subject to such additional details as the Chief Signal Officer of the Army may prescribe at the time.

(6) Before acceptance a trial endurance flight will be required of at least one hour during which time the flying machine must remain continuously in the air without landing. It shall return to the starting point and land without any damage that would prevent it immediately starting upon another flight. During this trial flight of 1 hr. it must be steered in all directions without difficulty and at all times under perfect control and equilibrium.

(7) Three trials will be allowed for speed as provided for in paragraphs 4 and 5. Three trials for endurance

as provided for in paragraph 6, and both tests must be completed within a period of 30 days from the date of delivery. The expense of the tests to be borne by the manufacturer. The place of delivery to the government and trial flights will be at Fort Myer, Virginia.

(8) It should be so designed as to ascend in any country which may be encountered in field service. The starting device must be simple and transportable. It should also land in a field without requiring a specially prepared spot and without damaging its structure.

(9) It should be provided with some device to permit of a safe descent in case of an accident to the propelling machinery.

(10) It should be sufficiently simple in construction and operation to permit an intelligent man to become proficient in its use within a reasonable length of time.

(11) Bidders must furnish evidence that the government of the United States has the lawful right to use all patented devices or appurtenances which may be a part of the flying machine, and that the manufacturers of the flying machine are authorized to convey the same to the government. This refers to the unrestricted right to use the flying machine sold to the government but does not contemplate the exclusive purchase of patent rights for duplicating the flying machine.

(12) Bidders will be required to furnish with their proposal a certified check amounting to 10% of the price stated for the 40-mile speed. Upon making the award for this flying machine these certified checks will be returned to the bidders and the successful bidder will be required to furnish a bond, according to Army Regulations, of the amount equal to the price stated for 40-mile speed.

(13) The price quoted in proposals must be understood to include the instruction of two men in the handling and operation of this flying machine. No extra charge for this service will be allowed.

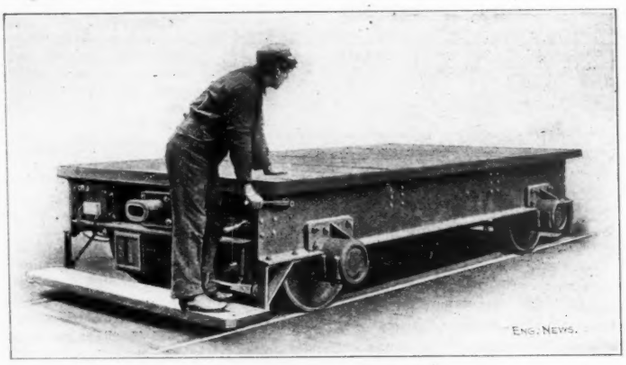
(14) Bidders must state the time which will be required for delivery after receipt of order.

James Allen,
Brigadier General, Chief Signal Officer, United States Army.

Signal Office, December 23, 1907.

STORAGE-BATTERY, MOTOR-DRIVEN, SHOP TRUCKS.

The difficulty of cheaply and satisfactorily transporting material or unfinished parts of apparatus from one section of a large factory system to another was overcome by the Westinghouse Machine Co., of East Pittsburg, Pa., in its own plant, with the use of storage-battery, motor-driven, trucks of simple design and construction. Formerly small, cast-iron trucks of 3-ft. gage, whose load was restricted to a few tons, were pushed about by hand. The heaviest castings were transported usually by 50-ton trucks which were moved by a rope passing from a crane hook through a snatch block to the truck. It is stated that with the employment of the auto-trucks a great improvement was noted; delays in handling material were obviated, the number of laborers about the shop was decreased and the crane service was facilitated by being freed from the duty of hauling heavy castings by ropes and blocks. On account of the success in their plant this concern has placed a line of these trucks on the market. The capacities range from 10 to 40 tons, in six-track gages; 18, 21½, 24, 30, 36 ins., and 4 ft. 8½ ins.



A TEN-TON, STORAGE-BATTERY, MOTOR-DRIVEN, SHOP TRUCK.
(Westinghouse Machine Co., East Pittsburg, Pa.)

A steel frame, made up of channels, well braced, is carried on four wheels, the journals of which run in roller bearings. The motor is suspended, through springs, from the frame at the operating end and is connected to the driving axle by reduction gears. The batteries are carried by angle-iron cradles suspended, by springs, at the center and one end of the frame. This battery is designed to operate at high rates of charge and discharge and the customary weight and ampere-hour capacity is cut down, as it has been found the time available for changing is three times that in service.

At the operating end of the truck are mounted the controller, brake, charging receptacle, cut-out switch and volt-ammeter. A step and draw-bar head are provided at each end. All the machinery is below the top of the frame and is covered by a heavy wooden deck, as shown in the accompanying figure. This deck is made in sections, so that parts of the mechanism are readily accessible.

The motor and controller are standard vehicle types. Four speeds in either direction may be obtained.

For track systems provided with turntables, trucks are made with rigid axles. Where tracks are installed with curves, the trucks for all gages up to 36 ins. are provided with a swiveled front axle, permitting free operation on curves as low as 12 ft. in radius.

During a six months' test of a standard ten-ton truck the power required to charge the battery in regular heavy shop service was accurately metered. It averaged 63 KW.-hrs. per month. At the high figure of 5 cts. per KW.-hr. the cost for the current would be only $3.15. The work done was recorded and averaged practically 700 ton miles per month, the loads running from a few hundred pounds to some fifteen tons. These trucks used as locomotives on a level track, without any load to secure track adhesion, can haul, on suitable cars, from one-half to full rated capacity as a truck, depending upon the condition of the track and kind of bearings on the cars hauled. By placing sufficient weight over the drivers to secure adhesion, they are capable of handling from one to two times their capacity as a truck for a continuous period of not more than five minutes.

DUST EXPLOSIONS IN AMERICAN COAL MINES.

Apropos of our comments in recent issues on the disastrous coal mine explosions recorded in December, we find in the "Pittsburg Dispatch" of Dec. 20 a report by Mr. J. L. Dixon, E. M., who was employed by the "Dispatch" to investigate the explosion at the Monongah mine. We quote from the report as follows:

Quite recently two coal mine explosions sent a thrill of horror through the civilized world; nearly 400 men and boys lost their lives, hundreds of widows were made and more than a thousand children are fatherless. One of the explosions was at the Naomi mine, Pennsylvania, the other at Monongah, W. Va. Already the intense excitement has died away, the adjoining mines are working as usual, and the mines where the disasters occurred are being prepared to resume operations. As the operators, mine and State officials, mining journals and newspapers claim that every method of safety was used, that nothing was left undone, no expense spared to secure the safety of mine and men, it is therefore reasonable to conclude that the same methods which obtained before the late dreadful disasters will again be put into force. Since the same conditions exist in the mines there is no reason why the same awful holocaust may not be re-enacted.

We are told in the case of the West Virginia mine that it was considered the safest and the best equipped mine of all those owned by the great Fairmont Coal Co. This company is noted for the splendid modern equipment of its mines, for the high efficiency, practical experience and technical skill of its engineers and mine officials. In this particular mine or mines they had a highly efficient system of ventilation, having concrete stopings, iron and concrete overcasts, split air system and splendid fans, there probably was no better in the country.

If this was considered one of the very safest of mines, it makes one contemplate with horror the unspeakable danger to which thousands of our fellow men are daily subjected, for if they are working where precautions for their safety are not so great, and where the natural danger is greater, we may naturally expect that the past will prove prophetic of the future.

Now let us inquire whether it is necessary that so many victims should be offered up as sacrifices on the altar of the country's industry and prosperity; whether or not there is some effectual method or methods which will prevent the recurrence of these dreadful explosions, with their attendant horrors.

I firmly believe that, so far at least as coal dust explosions are concerned, and very largely so far as gas explosions are concerned, they can be almost, if not wholly, prevented.

There are scores—I might say, without exaggeration, hundreds—of mines where the same or worse conditions exist as existed in the mines which recently exploded; the same mining methods are pursued, the same system of ventilation, same haulage, same mining machinery and same mining regulations—an explosion is potentially present in all of them; a blown-out shot, an electric spark, an open light may make it at any time an actuality, and unless a remedy is found and applied another explosion will take place in the future as in the past, only with increasing frequency, for with deeper mines and the introduction of modern coal-cutting machinery the danger is rapidly on the increase.

While it is admitted and acknowledged that a large number of mines are equipped with up-to-date and efficient ventilation machinery and with approved ventilation systems, yet I confidently affirm that in the majority of our mines, and especially in those where electric coal-cutting machinery is used, the most elementary, the most vital and necessary precautions are not observed, and that from the lack of these precautionary measures all coal dust explosions and many gas explosions occur. I furthermore confidently affirm that if the methods hereinafter set forth in this paper are strictly observed, explosions in the future will be as infrequent as they have been frequent in the past.

That coal dust will and does explode with the most disastrous results is no longer questioned by intelligent mining men. Its explosive force, weight for weight, is said to be four times greater than that of gunpowder.

The introduction of electric coal-cutting machinery has intensified the danger, for it supplies the ammunition in large quantities and furnishes the spark to complete the operation.

In order that those not acquainted with this method of mining may get a better idea of this, and in order that it may be made plain how coal dust explosions occur, and how they may be easily prevented, let us start at the point where the dust originates and follow it to its destination. The chain machine in undermining makes a uniform slot or channel four to five inches high and six feet under; thus in each room 25 feet wide nearly two tons of explosive coal dust are manufactured; or in a mine having a seam 5 ft. thick and producing 1,000 tons of machine mined coal per day, 100 tons is dust, that is exclusive of fine coal produced by blasting or breaking up the coal for loading.

Because of the nature of the undercut very heavy blasts are necessary to break down the coal; the holes for these blasts or shots are for the most part drilled and charged by ignorant foreigners, and without removing the dust or treating it in any way the shots are fired. In case the shot blows out the tamping (blown out shot) a long tongue of flame is projected into the room, on the floor of which is lying, all exposed, two tons of dust, which, when exploded, equals in destructive force eight tons of powder. Think of this and add to it the scores of tons which are distributed throughout the mine, and then you will cease to wonder at the tremendous manifestation of force, the results of which are seen after one of these explosions.

After the coal is shot down the dust and coarser coal are loaded into the mine cars and the cars are started outward on their journey. These cars are not by any means dust 'proof: they are built of oak planks, with spaces between, both in bottom and sides,, consequently, as soon as the cars begin to move the coal dust commences to filter through these spaces and keeps on running through until it has all run out or until the cars have reached their destination. Keep in mind, there are a hundred tons of dust, carried in from 500 to 750 cars, depending on their size; these cars travel on an average from one to three miles at a rapid rate, and every car constantly adding its quota to the explosive, death-dealing train. This process goes on from day to day, from month to month, until the mine is a veritable magazine of terrible possibilities, which, as we know too well, often results in the most dreadful eventualities.

The remedy for this is so simple and so obvious that it seems almost unnecessary to mention it, and yet, al-

though it must be patent to every mine foreman, superintendent or inspector, it is never used and probably will not be until it is made compulsory by stringent laws carrying a jail penalty for their non-observance.

The remedy is simply this: After a room or entry has been undermined by machine and before a shot has been fired, the dust should be thoroughly soaked with water and the roof, sides and floor of the room should be sprayed for 25 or 30 ft. back from the face. This should be done in every room and entry, which would make a coal dust explosion in the rooms and entries in juxtaposition to the face an absolute impossibility. So far as the haulage ways are concerned, there would be very little, if any, dust deposited if the above method were used, but owing to the method in vogue of chunking, that is of loading the cars from 6 ins. to 18 ins. above the sides, a great deal of coal falls from the cars during transit, and, unless it is removed, soon becomes dust. All the roads must be kept scrupulously clean and free from coal dust. In plain words, there cannot possibly be a coal-dust explosion unless the coal dust is present, and there is absolutely no excuse for its presence.

"But," says Mr. Objector, "this costs money." Well, so do explosions; they cost also untold misery and suffering, also valuable lives—probably more valuable than yours, Mr. Objector. Certainly as dear to them and theirs as yours to you and yours. The cost would amount to very little if installed at the opening of a mine. It would not cost for material, water and labor more than 1 ct. per ton. Surely a small amount to pay for safety of life and property. I think any operator would be willing to pay this as insurance against explosions, and I hope to be able to convince the mining men of this country that explosions can be prevented, and that the opinion given by several eminent investigators, viz., that "there is nothing either in the management of mines or in the law that can prevent explosions" is utterly without foundation.

As I write this the tragic news is wired from Alabama of another dust explosion, caused by a blown out shot; this also was deemed a safe mine, and I suppose it was until a long tongue of flame was projected into inflammable and explosive dust. Was it necessary to fire this shot with all the men in the mine? Was it necessary to fire this shot before the dust in the room was rendered harmless by water, or entirely removed? And yet so-called experts say it cannot be helped.

Suppose a lunatic should fire a pistol into a barrel of gunpowder in a crowded hall and kill a hundred people, these gentlemen would say, "The hall was perfectly safe." Yea, verily, minus the powder and the lunatic, safe enough. So it is with the mines, minus the blown-out shot and the dust, safe enough. Both of them can be eliminated and the stigma of this continual slaughter removed from our much-defaced escutcheon. Regarding gas explosions, I am of the opinion that very few of these occur. Generally, it is gas and dust combined, and could not have happened without being supplemented by dust. A small quantity of light carburetted hydrogen is as a rule present in the air of gaseous mines, and is readily detected, but being very far below the percentage necessary to form an explosive mixture is in itself harmless, but in combination with coal dust is excessively dangerous, which is another potent reason why the methods set forth in this paper should be observed.

In the case of the Monongah mine with its splendid system of ventilation, no gas explosion could have wrought one-tenth of the havoc or caused one-tenth of the loss of life as the dust explosion; it would have been confined to one portion of one of the mines, to one of the portions ventilated by a split, but a coal dust explosion is a different thing. It is a devouring monster, traveling with incredible rapidity, transforming almost instantly with its fiery tongue the accumulations of coal dust into countless millions of cubic feet of deadly poisonous gas, which expands with such irresistible force that nothing built by human hands can withstand it.

A properly ventilated mine is, under ordinary conditions, in no danger of a gas explosion. The extraordinary conditions to guard against are gas wells, which may be drilled in the territory, and the sudden breaking out of gas from natural fissures. The first of these can be guarded against by accurately locating these on the mine map and taking the proper precautions. The second is more serious and in gaseous mines can only be guarded against by eternal vigilance, in which must be observed the inviolability of the safety lamp, the exclusion of all sparking electric machinery and all the rules in force locally and by law for the prevention of explosions.

Laws should be passed as follows:

(1) Machine cuttings to be thoroughly dampened before shots are fired and before dust is loaded out.

(2) Roads to be kept free of coal and coal dust by loading out same after sprinkling.

(3) No shots to be fired while the men are in the mine except by special permission of mine foreman, and in no case before all dust in working place has been soaked with water.

(4) No shooting from the solid.

(5) The absolute prohibition of electric machinery in gaseous mines.

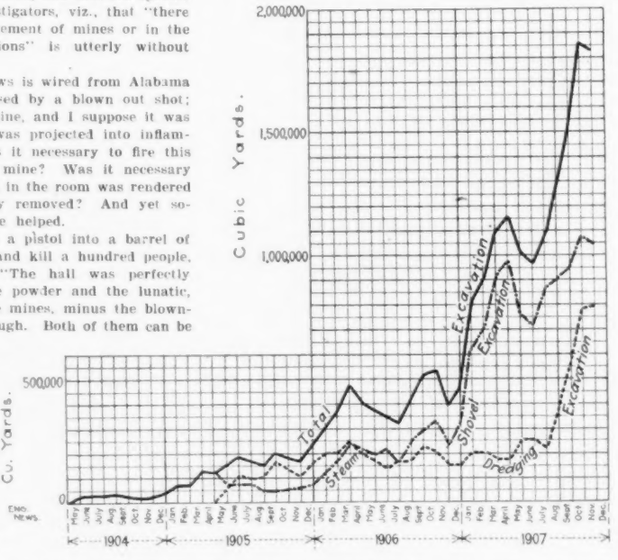
(6) Punishment by imprisonment for violation of law by either mine officials or workmen, and in case of fatal results traceable to non-fulfillment of law, guilty parties to be sent to penitentiary for not less than one year or more than twenty.

(7) The establishment of safety chambers which can be used as places of refuge by the survivors of explosions.

We may note that rules for the prevention of explosions similar to those laid down by Mr. Dixon were promulgated in Europe nearly a quarter century ago and have long been in force there.

THE AMERICAN RECORD OF MONTHLY EXCAVATION ON THE PANAMA CANAL.

We present herewith a diagram which has been compiled by the Isthmian Canal Commission and which shows the monthly progress in the amount of excavation both by steam shovel and dredge on the Panama Canal from the time of the American occupation, in 1904, through November, 1907. Although by no means the entire work in building the canal, the excavation



CURVES SHOWING THE TOTAL EXCAVATION ON THE PANAMA CANAL, MAY, 1904-NOV., 1907.

is the chief tangible evidence of the progress of the construction and is therefore of great interest as a means of judging the extent of the operations now being carried on.

The total excavation here presented includes not only earth removed from the canal proper, but also all other excavation in harbor work, subsidiary channels, railway fills, etc. In few cases do these minor elements comprise over 2% of the entire earth removed, so it can be practically said that the records show the amount of earth excavated from the canal prism, including locks. As would be expected, the long period of preparation in which plans were being made and equipment installed shows markedly in the curve. In fact, it was not until the beginning of the present year that the returns for the millions of dollars expended in preparation and equipment began to be apparent in the excavation records. It will be noted that in each year there are two slumps, the larger reaching its low point about July and the other about November. The former is no doubt due to the rainy season, which starts about April and reaches its height in July, gradually dropping off about December. The November slump must be due partially at least to the shortness of a month having but 30 days, including one holiday. For instance, November, 1907, had a total of 1,838,486 cu. yds., or a daily average of 76,600 cu. yds. for 24 working days, while October of the same year had a total excavation of 1,868,729 cu. yds., but a daily average of only 68,314 cu. yds. for 27 working days.

By taking the quantities to the nearest ten thousand off this set of curves it is found that for the eight months in 1904 there was a total excavation of 240,000 cu. yds.; for 1905, 1,900,000 cu. yds.; for 1906, 5,000,000 cu. yds., and for the eleven months of 1907, 13,600,000 cu. yds., a total of 20,740,000 cu. yds. The estimated total excavation on the entire canal made by the minority report of the commission of experts in 1906 was 96,000,000 cu. yds.

THE SOUTHERN PACIFIC R. R. has recently completed what is known as the Bay Shore Cut-off, by which the road will in future enter San Francisco. By means of this new southern entrance into the city the S. P. R. R. saves about five miles in distance, several hundred degrees of curvature and the heavy grades of the previous coast line, in addition to bringing some nineteen towns on the way to San Jose into much closer communication to San Francisco. The ten miles of new work includes two miles of tunnels, two miles of trestle and six bridge crossings over city streets.

ELECTRIC HEATING APPLIANCES seem to have found a new field of use in engineering repair work. A brief note in the "Electrical World" of Dec. 21 is suggestive, and may be found useful. In the instance noted it was found necessary to replace a 6-in. crank pin in 500-HP. cross-compound engine. The pin had a taper of 1-64 in., and was to be tightly fitted into a 5-in. disk carried by a 12-in. shaft. As the use of blow-torches was considered unsatisfactory here, several heating units from 6-lb. electric flatirons were assembled on an iron core and placed in the crank pin hole. The units were kept at nearly white heat for about four hours, when the disk had expanded enough to allow the pin to be slipped into place.

A NOVEL AND EFFECTIVE LINING for tube mills, the invention of Mr. J. R. Brown, is being exploited by the Blaisdell Company, 334 Pacific Electric Building, Los Angeles, Cal. The abraisive lining is furnished by pebbles, of the initial charge, which have become wedged into the channels, in the segments of iron or steel which form the metal lining, being bolted to the shell of the tube mill. As a pebble becomes warm or fractured and drops out it is automatically replaced by one which is hammered into its place by the revolving of the mill. Tests have shown that the wear is borne largely by the pebbles. In tube mills 20 × 4 ft. and 24 × 5 ft., at El Oro, Mexico, these linings gave service for ten months each, where smooth white iron lining lasted only three months, and "silex" blocks were used four months. It is stated that a mill may be emptied, relined and refilled ready for use in 24 hours by the same amount of labor necessary to install an ordinary smooth iron lining.

REMARKABLE BREAKS IN A WATER AND IN A gas pipe, causing a leakage of water into a gas main, were reported by Mr. R. C. P. Coggeshall, Superintendent of Water-Works at New Bedford, Mass., at the December meeting of the New England Water Works Association. The breaks are particularly interesting inasmuch as they may have been due to electrolysis. Water appearing at the ground surface, the Water Department made an unsuccessful examination for a leak. A little later the local gas company found water issuing from a drip box on its gas mains, and soon after this, whenever a gas burner was opened in the affected district, a jet of water was obtained instead of gas. A leak was finally discovered in a 4-in. hydrant branch which crossed over, and about one-half inch above, a 6-in. gas main, the leak being approximately located by the humming sound of escaping water. No water was actually found until the digging reached within a foot of the leak. On careful examination it was found that there was a hole in the bottom of the hydrant branch and a corresponding hole in the top of the gas main. The holes were almost alike in size and shape, measuring about 1¼ × 1½ inches. Electrical measurements showed less than one volt difference in potential between the gas and water mains, and the current flow from the gas main to the water main was about 0.4-ampere. The cast-iron pipe showed none of the graphitic appearance usually accompanying electrolysis, but the metal looked more like iron which had been fused. The most plausible explanation offered was that a high-tension electric current short-circuited through the two pipes at this point.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Candler Building
RUDOLF MOSSE, BERLIN AND HAMBURG, GERMANY

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Entered at the New York Post Office as Second-Class Matter

The fighting of fires is nowhere done with greater difficulties and dangers than in the underground passages of a mine. A long list of appalling disasters in the coal-mining industry are chargeable to the outbreak of fires. While the fire risk is less serious in the underground workings of mines where metals or uninflammable minerals are won than in coal mines, the vast amount of timbering furnishes an ever-ready source of a conflagration.

In April last, the Homestake mine in the Black Hills district, one of the largest gold producers in the world, was the scene of a fire which broke out 500 ft. underground and defied all attempts to control it until the mine was finally flooded. Elsewhere in this issue, Mr. Bruce C. Yates, M. Am. Inst. M. E., Assoc. M. Am. Soc. C. E., gives an interesting account of this fire and the methods adopted in fighting it, which will interest every engineer in charge of underground mining operations.

We commented last week on the ineffectiveness of the criminal law as an instrument for the prevention of railway accidents. The prosecuting attorney of New York attempted to fix responsibility for the Woodlawn disaster, which occurred last February, upon the General Manager of the New York Central & Hudson River R. R., and the Court directed the jury to render a verdict of acquittal, no substantial evidence of criminal negligence having been presented by the prosecution.

In Washington at the same time the courts were trying for manslaughter the crew of the train which crashed into the rear of a suburban train at Terra Cotta, Md., on the night of Dec. 20, 1906. That the accident was due solely to the engineer's blunder, the evidence almost conclusively proved. There appears little possibility to doubt that the block signals were set against the following train and that its engineer was running too fast in a night of dense fog to properly identify the signals as he passed them. Yet the jury returned a verdict of not guilty, and this verdict furnishes a fresh illustration of the obstacles which beset the effort to increase the safety of travel by attempting to convict the person chiefly responsible for the accident.

We do not say that prosecutions for criminal negligence should never be undertaken. On the contrary, where such negligence can be established punishment ought to follow as a warning to others against similar carelessness. What we do wish to point out is the folly of placing chief reliance on such trials as a means of reducing our present appalling accident record.

The advantages of municipal plants for repairing asphalt pavements are now generally conceded, at least by representatives of municipalities. The main claims for such plants are (1) that by their use repairs may be made far more promptly than a city can get a contractor to act; (2) that this promptness lessens the necessary repair work, by greatly restricting the wear at the edges of defective spots as well as the injury to the concrete foundation; and (3) that because of (1) and (2) and also because a city aims "to make no profit" municipal repairs are much cheaper than those made by contractors. In general, we believe all these claims are warranted, but we wish to call attention to the fact that in stating the savings effected by municipal asphalt repair plants the comparisons between municipal and contract costs are very seldom fairly made. The reasons for this generally lie in overlooking all the elements of cost of owning and operating a municipal plant, and in a strong desire to make out that such a plant is a money saver. Every contractor knows that he cannot repair asphalt pavements or do anything else without a working capital, and that his contract price must cover interest and depreciation on his outlay, as well as ordinary charges for operation. Municipal officials frequently omit interest charges from the yearly cost of a repair plant and it is very rarely that they make any allowance for sinking fund and depreciation charges. Besides these major omissions of cost items, city officials are prone to ignore charges for material or labor supplied by other city departments.

In contrast with common municipal practice we take pleasure in noting that those responsible for the municipal repair plant (not for paving work) of the city of Chicago, described in our issue of Dec. 5, have secured a working capital of $100,000, which is kept intact by collections from other departments for services rendered, and that in figuring costs the outlays for labor and material are increased by 10% in order to cover power, lights, stationery, clerical, engineering and like services.

This is the only instance we can recall where any kind of a municipal repair plant has made the same general provision for keeping its original outlay intact as must be made by every contractor to keep himself from ruin.

The latest failure to charge interest and depreciation to the cost of municipal work, that has come to our attention, appears in the report on the municipal asphalt repair plant at New Orleans, La., abstracted elsewhere in this issue. Cash outlay for plant and yearly outlay for supplies, labor and superintendence, appear to have been recorded with unusual care. This done, the author of the report ignores his capital outlay and divides the sum total of operating expenses by the total yardage of pavement repaired in 1906-7, and then sets the quotient against the yardage cost for the first year under the contractors' bid, by years, for maintaining the asphalt pavements of New Orleans for a period of three years. Obviously, the contractor had to make his bid large enough to bring him back, inside of three years, all his investment, all operating expenses and profit on his working capital. Moreover, the contractor assumed that the city would require far more repair work in the first year than would be demanded in the second and again in the third year, and, accordingly he bid $114,000 for the first year and $40,000 each for the next two years.

The report states that the pavements were in very bad shape when the bids were opened, and intimates that the bidders assumed that they would be called upon to repair a large part of the whole asphalt area during the first year. Whether the city repaired a larger or smaller area than the lowest contract-bidder would have been called upon to repair is a matter for conjecture. In addition to this uncertainty as to using a proper yardage for comparing city cost and contract price the report gives evidence that the city, in its repairs, did not follow the contract specifications.

We have not raised these points regarding the New Orleans report to question the wisdom of or the saving effected by the municipal plant, but merely to illustrate the point that municipalities as well as contractors ought to take account of capital charges, particularly when comparisons of municipal and contract work are being made.

THE NEW YORK COMMISSIONERS OF ACCOUNTS ON THE ASHOKAN RESERVOIR DAMS AWARD.

For acting upon the advice of Prof. Wm. H. Burr, Messrs. F. P. Stearns, John R. Freeman and J. Waldo Smith, Ms. Am. Soc. C. E., and awarding the contract for the great Ashokan Reservoir dams to other than the lowest bidder, the three members of the Board of Water Supply of New York City have been charged by the two Commissioners of Accounts of the same city with "incompetency and misconduct" and are recommended for removal from office.

In our issues of Sept. 5 and Nov. 21, 1907, we gave the main facts regarding this award and expressed our opinion on the subject. Our opinion was that, in the light of the evidence then in hand, the action of the Board of Water Supply and its engineers was amply justified. The results of the extended hearing recently closed, so far as they are yet available, strengthen our belief that the Board of Water Supply, in justice to the city and itself, would not have been justified in awarding the contract to the lowest bidder. The reasons for the action of the Board, together with a brief resumé of the report of the Commissioners of Accounts, are given elsewhere in this issue.

Without in any way questioning the motives of the Commissioners of Accounts it seems to us that throughout this whole matter they have failed to do justice either to the engineering questions involved or to the members, engineers and consulting engineers of the Board of Water Supply. They appear to us to have laid altogether too much stress upon the lowness of bids as a reason for contract-awarding and far too little upon the primary object of contract letting, which is to get a given piece of work done and well done—and, in this case, quickly done.

The Commissioners also seem to have failed to perceive that a municipal administrative board, composed wholly of business men rather than engineers, cannot do otherwise than rely upon their engineering advisers in all matters of engineering and of engineering costs. In addition to this, the Commissioners of Accounts appear to have been sadly misled as regards the applicability of minutely detailed cost analyses, based on previous works, to an unprecedentedly large dam contract, extending over a period of seven years, and subject to numerous changes in the labor, material and money markets.

The Commissioners of Accounts appear to have thought that the members of the Board of Water Supply should have regarded its engineers as witnesses against a criminal at the bar (the lowest bidder), and that acting accordingly, the Board, instead of trusting the knowledge, judgment and integrity of its engineers, should have subjected them to a searching cross-examination before the award, both as to their competency to pass on the bids and as regards all the engineering and other data on which they based their opinions.

Let us see what total-cost figures the Board of Water Supply and its engineers had before them when the contract was awarded. They were as follows:

Bid of John Pierce Co.	$10,315,000
Bid of MacArthur Bros. Co. and Winston & Co.	12,670,000
Estimate of T. Merriman, Asst. Engr.	$12,506,000
Estimate of Fred. F. Moore, Des. Engr.	12,748,000
Estimate of C. E. Gregory, Des. Engr.	13,020,000
Average of above-named three engineers	12,758,000
Estimate of J. Waldo Smith, Chief Engr.	12,850,000
Bid of Bradley Contracting Co.	13,931,000
Bid of Stewart-Kerbaugh-Shanley Co.	13,980,000
Bid of O'Rourke Eng. & Contracting Co.	14,708,000

With these figures before them and with the knowledge that the lowest bidder was inexperienced in earth dam construction and was willing

to be passed over, and with the advice of its engineering staff to reject the lowest bidder, was not the Board of Water Supply justified in awarding the contract to the next to the lowest bidder, who was known to be of large experience in and already equipped for the kind of work involved?

We commend to the careful examination of those interested the final conclusions of the Commissioners of Accounts, reprinted elsewhere in this issue, and particularly the third paragraph of those conclusions. We have seen only a small part of the evidence taken by the Commissioners, but we have carefully examined the Commissioners' own review of the evidence. We find nothing in their report to prove that the lowest bidder actually believed "that he could secure a reasonable profit at his prices"; nor do we find any proof that the Board of Water Supply was without evidence that the inexperience charged against the contractor would not have delayed or imperiled the work.

Of course it is clear that the testimony on these and other points did not satisfy the Commissioners of Accounts that the award should not have gone to the lowest bidder; but it must be remembered that in reaching this conclusion the Commissioners of Accounts are on an altogether different footing from the Board of Water Supply. The Commissioners have no responsibility for the prompt and proper performance of one of the greatest engineering works the world has ever seen—a work on which rests the security of the greatest city of the New World against a water famine. The Commissioners' report shows no appreciation of the huge responsibility the Board of Water Supply would have assumed had it let the contract to the lowest bidder against the advice of its own engineers.

One sentence in the Commissioners' conclusions is worth special attention. We quote:

> A two weeks' inquiry has demonstrated that all which developed at our hearings might easily have been within the knowledge of the members of the Board had they been as active in investigation as they were ready to rely solely upon the opinion of others.

Surely this quotation makes clear the fact that the Commissioners of Accounts wholly fail to understand the function of a non-technical administrative board and its technical advisers. If the Board of Water Supply could not rely upon the estimates and opinions of its engineers without conducting a two weeks' court inquiry on every contract award, then the Board ought to employ engineers whom it could trust.

As we have already stated, the questions at issue now go to Mayor McClellan. Two laymen, city officials, advised by four engineers, have virtually prosecuted and passed judgment on three other laymen, city officials, advised by one of the largest and most efficient engineering staffs ever created, and supported, in effect, by the bids of several contracting firms of large experience.

The Board of Water Supply has not had the privilege of seeing the report of the engineers employed by its prosecutors, the Commissioners of Accounts; has not been represented by counsel at the hearing; and has not had an opportunity to produce witnesses on its own behalf nor to examine those produced against it.

If Mayor McClellan carries the matter further it is understood that the members of the Board of Water Supply will have all the rights usually accorded to accused persons brought into a trial court. It would be idle to predict the final result of this unfortunate affair. Curiously enough, the outcome has no bearing whatever on the contract involved, since that was awarded months ago to the next to the lowest bidder, who immediately began work. Neither does the outcome affect the lowest bidder, for he willingly surrendered any rights he had in the premises.

In appointing the three members of the Board of Water Supply, Mayor McClellan fulfilled a pledge made when the Catskill water supply bill was before the legislature: namely, to select men of high character and large business experience to have charge of this $160,000,000 enterprise. The men so chosen and their eminent engineering advisers have received such treatment as would make it difficult to fill their places, in case they are forced out of them, by any but political office seekers. Such an outcome would be a great setback to good municipal government in New York and throughout the United States. We trust that Mayor McClellan will see the matter in this light and act accordingly.

THE BUSINESS SITUATION: 1907 AND 1908.

One year ago business in the United States was at a climax of prosperous activity. Prices in the stock market—the barometer of the financial world—were uniformly high. Manufacturers had more orders than they could fill, and were enlarging their plants and building new ones. Merchants were selling goods as fast as they could be placed on the shelves. Labor was in such demand everywhere that even the poorest and most inefficient workers were employed at good wages. Indeed, so great was the demand for labor that complaint was heard on every hand of serious falling off in its output. Men were so sure of jobs that they did not exert themselves to hold their places.

The year 1908 begins with a very different state of affairs. The Wall St. barometer has shrunk far down the scale. Manufacturers are hunting for customers to keep their works busy. Merchants report the slackest holiday trade in many years. Laborers by the thousands find themselves without employment; and an unparalleled exodus to Europe has taken place, taxing the utmost capacity of the transatlantic steamship lines. Prices are yielding all along the line, and where they are maintained it is by the influence of monopolistic combinations and not by the free operation of the law of supply and demand.

This remarkable transformation has not been brought about by any outward cause. The great staple crops of the farmer have been bountiful in quantity and the surplus not needed for consumption here is salable in Europe at high prices. The mineral industry has had a year of remarkable productiveness. No great calamities have occurred to wipe out the results of industry in the form of accumulated wealth. There has been no lack of Nature's gifts to cause the change from prosperity to dull times. To what then is the transformation due?

The first and most important cause of the financial collapse of 1907 is the relation between demand and supply in the market for investment capital. This is a cause which engineers can readily appreciate because it affects them so directly. There are hundreds of new engineering enterprises which are today at a standstill because bonds cannot be sold to raise the funds necessary for the work. And why cannot bonds be sold? Because for three years past the railways and the cities and the manufacturing and mining corporations of the country have all been engaged in great works of extension and development, and have put out larger amounts of securities for the investing public to buy than have ever been known before in the world's history. But there is manifestly a limit somewhere to the amount of money available for investment. The total amount that a man has to invest in any year is equal to his total income minus his outlay for current expenses. The amount of money a whole nation can invest in a year is equal to the sum of all these individual savings. If the bond and stock offerings of all the concerns seeking additional capital is in excess of these total savings—the aggregate investment fund, as we may call it—then some concerns will have to get along with less than they want or perhaps go without entirely. This is exactly what happened to thousands of concerns, great and small, in 1907.

Coincident with this huge demand for funds by corporations seeking to market stock and bond issues, there has been, it is believed, an actual reduction in the amount of capital seeking investment. A man may have a very large income and yet live so extravagantly as to have little or no money to spare for investment during the year. The same thing is true of a nation of extravagant men. The $440,000,000 which is estimated by Mr. M. E. Ingalls to have been spent on automobiles during the past few years represents in large part money which would otherwise have gone into the purchase of stocks and bonds and would have constructed railways, factories, buildings, water-works, etc.

Nor is it the wealthy alone who have been extravagant. The aggregate savings of the workers for wages and salaries accumulated in savings banks, is a more important reliance for the seller of bonds than the patronage of millionaires. But in the recent period of prosperity and high prices, money has been spent in all classes as easily as it has been earned.

We hear it said, however, that the reason why bonds and stocks cannot be sold is that people are infected with distrust of corporations. No one would deny that to a certain extent such distrust does exist. That it is far from being the chief factor in bringing about the present financial situation, however, can be proved in many ways. For example, high class municipal bonds whose safety as an investment is beyond question, are selling at lower prices than have prevailed for a generation.

It is true, of course, that the records of corporate maladministration which have been spread before the public during the past few years, have bred distrust of many of our great railway corporations and manufacturing combinations. The investing public as a whole has no means of discriminating between the corporation which is managed for the benefit of its stockholders and the one which is managed for the benefit of its managers.

This popular distrust of corporations is not a new thing, however. Innocent investors have been defrauded ever since the days of company promotion began. The looting done in Wall St. during the past decade is no worse than that which was carried on there a generation ago and which was so graphically described by Mr. Chas. Francis Adams in his famous "Chapter in Erie," except that the recent looting has been done on a vastly larger scale.

It is very much the fashion in certain circles to place the responsibility for the financial disturbance upon the administration, on the theory that people are afraid to buy bonds because of alleged Government hostility to corporations. Never was a theory more absurd. A bank may be looted by burglars and the depositors may start a run on it next day in consequence; but the policeman who gives the alarm when the robbery occurs cannot justly be held responsible for the run on the bank.

Further, as we have just shown, people are not alone refusing to buy stocks and bonds of railway and other public service corporations, but of other concerns where no whisper of government interference is heard, and the securities of cities as well.

The real controlling cause of the present financial depression, as we said at the outset, therefore, compared with which all others are insignificant, is the scarcity of investment capital, or scarcity compared with the enormous demand.*

But, it may be said with truth, this scarcity is not a new thing. For at least two years past, money for investment has been hard to get. In Wall St. parlance, the bond business has been dull. Four years ago a very similar condition occurred and in our issue of Oct. 15, 1903, we pointed out that the clogged investment market

*We should not be understood as claiming originality for the above diagnosis of present financial conditions. The same facts have been set forth by eminent economists, notably by M. Paul Leroy-Beaulieu of France, who is universally recognized as one of the world's highest authorities in economics and finance. He has repeatedly, during the past year, emphasized the exhaustion of the world's capital reserves as a condition fraught with danger to the financial system. In the New York "Evening Post" of Dec. 21 he is quoted as follows:

> It would be a great mistake to suppose that the crisis in the United States originated solely, or even principally, from lack of money in that country, or from defective organization of its banks.
>
> The actual cause of the crisis is the actual over-expansion of industrial enterprise in the world and the consequent insufficiency of the world's supply of capital. What has happened is that new enterprises have been started or old enterprises have been enlarged in a degree wholly beyond the sum total of the world's capital—that is to say, beyond the amount of capital actually produced by the savings of the whole civilized world.
>
> The error of the public at large consists in believing that, even if there are manifest limits to the financial operations of an individual or of an industrial corporation, there are no limits to the financial activities of a nation, especially if that nation be great and prosperous. But the truth is there most decidedly are such limits: the sum of available capital limits just as much the activity and financial expansion of a nation, however great it may be, as it does the activity of one man, or of a single commercial company.

was the main factor in bringing about the trade depression that occurred in that year.

As it is well known that even back in 1906, railway and other corporations were borrowing money on short time notes because of inability to sell bonds on satisfactory terms, it may be well to explain the reason why the financial collapse did not occur earlier.

It can readily be understood that the banks and other financial institutions act as a reservoir between the borrowers of money and the lenders. In ordinary times there is an accumulation in this reservoir sufficient to supply the necessities of borrowers; but when the amount in storage is reduced too low, there is danger of financial collapse just as certainly as low water in the reservoirs supplying a city is a condition of danger.

Again, in ordinary times the supply of capital to the bond market and the supply to mercantile borrowers do not interfere with each other. The banks loan to the latter at 6% or better while bonds are sold to permanent investors at prices to net 3% to 4%.

In 1906 and 1907, however, the demands for new capital by railway and other enterprises could not be met by the sale of bonds and instead huge amounts of short time notes were put out bearing interest as high as that paid by mercantile borrowers. In this way, during two years the level in the reservoirs of accumulated capital was steadily lowered, and funds badly needed for carrying on mercantile and manufacturing business were diverted to investments in permanent enterprises where they were no longer in liquid form. To put it another way, a vast amount of banking capital needed for loaning to merchants and manufacturers on short term notes where it could be promptly paid and returned to the bank, was instead loaned to railway and other enterprises, where its return was only possible through bond flotations at some future time.

It was the dangerous situation thus created which caused the financial panic of 1907. The circumstances which finally precipitated the crash are comparatively unimportant. A run upon a New York City bank spread to other banks and trust companies and found their reserves so depleted, as just explained, that they were in no condition to withstand the drain.

The efforts of the banks to meet the legitimate necessities of trade, with their reserves depleted in the manner above explained, were greatly hampered by our defective currency system. The need of elasticity in the currency and particularly of legislation to facilitate the use of some form of credit currency in emergencies like that of the past few months has been powerfully impressed upon the public mind. People have had an object lesson of the great service that such credit currency can render in keeping the wheels of industry in motion at times when other forms of currency prove insufficient. Congress will be most derelict in its duty to the nation if it does not enact a proper measure for remedying at least the most glaring defects in our currency system before the final adjournment of the present session.

And now, without taking space, for a more detailed review of the past, what of the year that lies before us.?

Temporarily, it is true the rate of investment fund production has been reduced below the normal. Men make money through the operations of trade and industry. Paralyze or even fetter these, as they have been fettered for three months past, and incomes are reduced all along the line, from the wageworker at one end to the millionaire at the other.

Fortunately, however, the normal flow of business has been already in great measure restored. The great bulk of production is after all for necessities and not for luxuries, and the production and buying and selling of these goes steadily on. The producers of wheat and corn and cotton and the other great staples, on the results of whose labors all prosperity finally rests, have had a highly profitable year. The November exports from the United States exceeded all previous records and the falling off in the consumption of imported luxuries gave a balance of trade in our favor of $93,000,000 in the 30 days of that month. The great railway and industrial corporations will disburse during the present month nearly $200,000,000 in interest and dividends.

All these things create new supplies of funds for use in production enterprises. Of course it is not to be expected that new construction work will go forward during 1908 at any such pace as in 1906. Such a pace could not possibly be maintained because of insufficiency of the world's supply of investment capital, as has been shown above. The rise in interest rates, moreover, puts an automatic check on the demands for new capital. A large proportion of the works which would prove profitable with money at 3% would show a loss at 6%. It is a case of survival of the fittest, and at the present high rates for capital only those new works will be undertaken which are so necessary or so profitable as to justify the present high rate.

One thing, however, which partially offsets the high interest rate is the lowering of the wages and—still more important—increase of the efficiency of labor, which has accompanied the reaction in the business. Broadly speaking, the cost of any great work is the cost of the labor put into it. The original raw material cuts but a trifling figure. That cost will depend as much on the rate of production of the individual worker as upon the wages he receives. The past two years has seen the highest wages paid to labor and—it is generally stated by employers—the lowest efficiency ever known.

The year 1908 opens with an overstocked labor market and plenty of good men available for contract work. It will be possible, therefore, to carry out work at a profit during the present year which would have been done at a loss during 1906.

It is customary in trade journals to refer to the work of the trusts and combinations in maintaining prices as a beneficial influence. Such an idea, however, is hard to defend on any sound theory of economics. It is better to have men and machinery carrying on productive work than idle, even though profits may be smaller than in flush times. A high price for raw material may be justified by the law of supply and demand under the conditions of 1906, and be unreasonable and extortionate in 1908. The resumption of activity in new enterprises will be fostered not only by reduction of wages and increase of the workers' output—Mr. Gompers to the contrary notwithstanding—but by a lowering in prices for all raw materials entering into production.

Finally the fact we have endeavored to make plain—the limits to the supply of investment capital—ought to be more generally recognized. A man cannot spend part of his income on one thing without having less to spend on something else and neither can a nation. It is common in times of financial stringency to hear it said that the nation ought to issue huge amounts of bonds and use the money thus obtained in public works to give the idle employment and keep business good. It ought to be evident, however, that money loaned to the nation and expended in such a way cannot be also loaned to railways to use in building extensions, or to cities to build water-works and school buildings. The recent bond issue of the Government was justifiable only as a means of bringing into circulation money supposed to be hoarded by private individuals, and replenishing the currency by furnishing new securities to bankers. When it developed that the money would actually have to be taken from the resources of the banks, where it was urgently needed to keep business from entire paralysis, the bond issue was practically abandoned.

Any absorption of investment capital means, inevitably, so much less available for investment elsewhere. The world would have had many hundred millions of dollars more capital available for productive enterprise during the past half-dozen years except for the Spanish war, the Boer war, the Russo-Japanese war and the destruction wrought at San Francisco and Baltimore. The advocates of peace and of national disarmament are on sound ground in their claim that the huge sums now expended on means for destruction are not only a terrible burden on taxpayers the world over, but are a diversion of funds which would otherwise be available for productive works of general benefit to mankind.

LETTERS TO THE EDITOR.

Floor Systems for Electric Railway Bridges.

Sir: In the article on the reinforced concrete viaduct of the Richmond & Chesapeake Bay Electric Railway, in your issue of December 12, one of the illustrations shows a narrow floor system entirely devoid of guard rails. It may be that the floor construction is not shown in complete detail, but certainly the arrangement shown is defective. Inside guard rails should be used on all bridges and trestles of considerable height or length, and are much more effective than the outside guard timbers upon which reliance is frequently placed. In this particular case, however, there seems to be little room for guard timbers, and both these and inside guard rails are omitted. This is for a long, high structure, with a curve, and it would seem that the derailment of an electric car at high speed would certainly bring about terrible casualties. The defective design might be expected (and is too often found) on timber trestles of country lines, but it would seem that a permanent concrete structure in a large city should have a floor system designed with a view to reasonable safety in case of derailments, since accidents of this kind occur on the best regulated railways, whether operated by steam or by electricity.

Yours very truly,

Bridge Engineer.

Chicago, Ill., Dec. 17, 1907.

Financial Wisdom from an Unexpected Source.

Sir: Although John L. Sullivan's best friends would probably not seek his advice on an important business proposition, many business men could well take a lesson in optimism from him at this time. He is now appearing at a local theatre and the following excerpt from an interview with him is worth reading:

It makes me tired to hear folks talking about the financial situation. Half the people who stand around talking about "stringency" and "situation" and such like things, only do it because they like the sound of the words. Half of 'em never heard the word "stringency" before, and they think it's smart to be heard talkin' about it. I think I've been knockin' around this world long enough to know hard times when I see 'em, an' I want t' tell you, young feller, there ain't nothin' to it. It's just a case of a few robbers down in Wall Street tryin' to hog all the money and fallin' down in the attempt. That's all there's to this "stringency" bunk. Then there's a bunch of sorehead fellers that thought they'd take a rap at my friend, President Roosevelt, an' bit off more'n they could chew. There's a man for your money or any honest man's, that same Roosevelt. I'm a Democrat, born in Boston, but I'm for Roosevelt. He ain't afraid of them Wall street guys, and when he says the people are goin' to get a "square deal," the people are goin' to get it, see? This country is all right. The people are prosperous and happy. We've been hittin' up a pretty hot pace and maybe we've got a little beyond the limit in some things, but what's the odds? We'll catch up again after we've had a little rest and do better'n ever. All I've got to say about the "financial situation" is, forget it.

Yours very truly,

Chain Belt Company,
Wm. C. Frye, Treasurer.

Milwaukee, Wis., Dec. 17, 1907.

Notes and Queries.

E. A. F., Portsmouth, Va., writes:

Do you know of any official tests of the holding qualities of square-head lag-screw expansion bolts and square-head machine expansion bolts inserted in rock, concrete or masonry?

We recall no tests on expansion bolts, although a number of tests are on record upon ordinary drift bolts secured in different ways.

J. S. R., of Philadelphia, Pa., asks: "When steam and hot water are turned into brick sewers for many years what effect do they have upon ordinary bricks and cement mortar?"

Working stresses in the members of the Forth Bridge were given rather incorrectly in a footnote to Mr. C. A. P. Turner's article: "Working Stresses in Steel Construction," in our issue of Dec. 12, 1907. They were quoted as: Tension, 22,400 lbs. per sq. in.; compression, 25,390; repeated stress, 14,930-16,800; alternating stresses, 7,470-11,200. They should have been stated as follows. For one kind of stress, 14,930 to 16,800; for alternating stresses, 7,470 to 11,200 lbs. per sq. in. The author, in a letter to us, further comments on the Forth Bridge specifications thus:

The average theoretical writer confuses the tenacity or ultimate resistance of the specimen in a tensile testing machine with the ultimate strength of the material in the structure, while the two, as pointed out in the article, have no more intimate relation to each other

than the yield point to the ultimate resistance in static test. This confusion is closely allied to the popular one, relative to the factor of safety in steel construction.

This factor of safety, alias factor of ignorance, is based on tenacity or ultimate resistance rather than on the ultimate strength of the metal in the frame, and the designers of the Forth Bridge make a clean-cut distinction between the two, and were further limited in their choice, to some extent at least, by the Board of Trade stipulations laying down the rule that the maximum working stress should not exceed one-fourth of the ultimate breaking strain of the steel, that is, ultimate resistance or tenacity developed in the static test of the specimen.

In the description of the concrete mixer and spreader in our issue of Dec. 12 (p. 645) it was stated that the highest record claimed for the machine was 1,000 cu. yds. of concrete in an eight-hour day. This should have read 1,000 "sq. yds." of concrete, base 6 in. thick. We have received several letters commenting upon this, all suggesting that "sq. yds." was intended, so that the unfortunate typographical error was evidently obvious to readers.

Even this is questioned as an incredibly high record, but the company building the machine states that 1,000 sq. yds. of 6 in. concrete base was actually laid in eight hours with the force stated. This would be 21 cu. yds. per hour, and with a mixer of 11 cu. ft. capacity would mean a batch of concrete mixed every 70 seconds, which would certainly require a hustling gang. Perhaps the "6-in. concrete" base ran a little thin. It often does.

A Montana correspondent writes:

Is there any exact method of finding overhaul where material is hauled from wide borrow pits into large embankments and hauled from a point in the borrow pits to a point in the embankment not opposite that where excavated? If you or any of your readers can furnish such a method you will greatly oblige.

We see no possible way of solving such a problem short of attaching cyclometers to the dump carts.

FINAL REPORT ON THE AWARD OF THE ASHOKAN RESERVOIR DAM CONTRACT, NEW YORK CITY.

After an investigation covering some two weeks, the Commissioners of Accounts of New York City have submitted a report to Mayor McClellan charging the Board of Water Supply with "incompetency and misconduct" in the matter of the award of the contract for the main dams for the Ashokan Reservoir, which is to be a leading feature of the new Catskill water supply for New York City. Following the report, which is a typewritten document of 60 pages, based, in turn, on 2,000 typewritten pages of testimony, the Commissioners will present formal charges to the Mayor, upon which it is supposed that the Mayor will give the members of the Board a hearing in order that they may present their defence to the charges preferred by the Commissioners of Accounts.

The whole point at issue is whether the Board of Water Supply was justified in awarding the contract for the dams at a price $2,355,000 in advance of the lowest bid ($12,670,000 against $10,315,000)—an award to other than the lowest bidder being wholly within the discretion of the Board; its staff and consulting engineers advising the award as made; all the other bids as well as all the engineers' estimates being far above the lowest bid; and the lowest bidder being a concern without experience in the class of work to be done.

The substance of the conclusions of the report is (and this the summaries of the testimony given in the report are designed to establish) that (1) the members of the Board of Water Supply relied upon the advice of their engineers in awarding this large contract; (2) that the engineers, in turn, had no basis of fact for asserting that the John Pierce Co. bid would be a losing one, and as such would subject the city to possible dangers through a water famine and also to possible although remote damage through improper construction; and that (3) the members of the Board of Water Supply, having relied upon the advice of their engineers, and having failed to discover that the advice was unsound, should forthwith be removed from office.

After preliminary statements, the Commissioners assert as the basis for the whole investigation that the award of a contract "at an advance of $2,354,000 over the amount of the lowest bid" seemed to be a "needless expenditure of public funds," that "made necessary an exhaustive inquiry into the causes and facts which underlay the action of the Board of Water Supply in rejecting the lowest bid."

On invitation, a member of the Board of Water Supply sat with the Commissioners of Accounts throughout the hearing. All questions which the Board, through its representatives, wished put to witnesses were so put [by the Commissioners, as we understand it]. The Commissioners declined to put their own engineers upon the stand, or to submit to the Board the report of those engineers, made prior to the hearing. This refusal the Commissioners defend by asserting that the facts that justified or condemned the award could be given by no one save those concerned in it, and that advisory engineers were retained by the Commissioners solely to give technical information on which to base the inquiry. The report states that the Board was given an opportunity to have one of its engineers examine on the stand the engineer of the lowest bidder, which opportunity was declined, but the report does not state that the Board was not represented by counsel and was not given the right of examining witnesses, except through the medium of written questions submitted to and propounded by the Commissioners, who really acted at once as prosecutors and judges.

The report declares that the discretionary power of the Board of Water Supply to award contracts to other than the lowest bidder, "while not without precedent, is unusual," but it gives no evidence to sustain a declaration which is certainly open to question. The report also, and properly, states that there rested upon the Board

a moral obligation . . . to accept the lowest bid . . . unless at the time of such rejection they have present in their minds cogent and sufficient reasons for such action, based upon fact, related to the public welfare and established to their satisfaction by thorough businesslike and intelligent investigation.

The major part of the report is devoted to quotations and criticisms of the testimony bearing on (1) the reasons of the Board for rejecting the lowest bid; (2) the steps taken by the Board to ascertain the sufficiency of those reasons; (3) whether the reasons were sufficient.

The reasons for rejecting the lowest bid, the report states, were fear of delay in the completion of the dam, and consequent danger of water famine, through the alleged inexperience and under-cost bid of the lowest bidder, "coupled with the further alleged fact that in the case of a losing contract delay invariably does and will result."

The gist of the case against the members of the Board of Water Supply, as we have already stated, is that they relied upon the advice and opinions of their engineers as to the sufficiency of the lowest bid, and as to related matters, and also upon the opinion of the lowest bidder that he was too low, and the fact that the other bids and the engineers' estimates were all much higher. One of the Commissioners, it appears, gave far less attention than did the others to this and other affairs of the Board. He frankly admitted that he knew nothing of the engineering questions involved, "believing [to quote from the report] that they were of such a nature as to be intelligible only to engineers." None of the other members, however, laid claim to engineering knowledge. It is amusing to note, in passing, that the Commissioners consider it of importance to record that this Board member "had visited the reservoir site three times in all, spending a day on the occasion of each visit." Whether this fact is recorded as the one bright spot in the member's service or as a severe condemnation, the context does not indicate.

The consulting engineers, according to the report, made but little investigation of the bids, basing their conclusions as to the wisdom of making the award to other than the lowest bidder chiefly upon their general knowledge of and experience with large contract work, and relying very largely upon the estimates made by the chief engineer and his assistants, and also upon the bids of the various contractors. Particular stress is laid upon the fact that the consulting engineers made no detailed cost analyses and that when before the Commissioners they could not or did not give cost analyses of steam shovel work.

The Chief Engineer and his assistants, according to the report, failed signally in "analysis and synthesis of cost" in making up their estimates, besides being unable to satisfy the Commissioners, on examination, that the John Pierce Co. would have lost money on its bid as a whole, or even on the earthwork. Neither these nor the consulting engineers, according to the Commissioners, proved that a losing contract necessarily results in delay in completing the work.

Regarding the John Pierce Co. and its bid, the Commissioners assert that neither the Board of Water Supply or its engineers ever got a declaration from Mr. Pierce that he would lose money on the whole contract, and in fact that the question was never put to him until he was examined by the Commissioners. Then Mr. Pierce admitted a probable profit of 10% on the whole contract, but said that the figures of his engineers (made in his absence) showed a profit of 20 to 25%. He saw no profit on the embankment items and considered that a 10% profit on the whole work was too low for a job of such magnitude, extending over so long a period. He had never abandoned a contract and (the Commissioners state) had the Board "held him to his bid, it was his intention to perform the letter of his contract."

Mr. Moore, the engineer who made the estimates for the John Pierce Co., on which the low bid was made, based his earthwork figures

in part upon his ability to conduct a spreading machine, designed mechanically to separate stones. He cited instances of several successful machines designed by him, and declared that he had never yet failed in an effort to produce a machine which would accomplish a result desired.

After reviewing at length the testimony taken by it the Commissioners state that

it will appear that the following conclusions are inevitable:

The members of the Board of Water Supply had one reason for the rejection of the lowest bid—the fear of delay—resting upon two causes, inexperience and a losing price. They had before them absolutely nothing to justify their conclusion that such causes either existed or were sufficient, except general statements of opinion and experience. Of these they asked no explanation or verification. They failed to take such steps to satisfy themselves of the accuracy of the statements made to them by their chief engineer and consultants as would be expected of ordinary business men of experience. They neglected to bring out the facts from the lowest bidder, and were content to authorize an increased expenditure of $2,354,425 of the city's funds upon a record which bears upon its face the evidence of its insufficiency.

There was before the board at the time of its decision upon this matter, absolutely no evidence that the Pierce bid in whole or in part was at prices below cost. There were but two cases before it to support the proposition that a losing price must bring about delay. After the lengthy examination of the board's witnesses, in which every effort was made to bring out the facts upon which they relied for their contentions in these matters, there is no evidence before us now which would justify a finding that the Pierce bid was in whole or in part below cost. There is no evidence before us which would justify a finding that delay always results from a losing price. On the contrary, upon the first head, we have the statement of the lowest bidder and all his representatives, that his bid prices would have insured him a 10% profit, while on the second we have an utter breakdown in every case cited us by the board's representatives on the stand, and even in one of the two cases cited by the chief engineer in his report.

The situation therefore presented was that of a low bidder of large financial resources, of good reputation, ready to perform and able to perform, believing that he could secure a reasonable profit at his prices, under heavy security for the faithful performance of the work, passed over by the Board of Water Supply upon the ground of inexperience and insufficient price, without evidence that the successful bidder possessed much greater experience, without evidence that the inexperience charged would delay or imperil the work, without evidence that the price was insufficient, and upon the advice that a satisfactory *quality* of work could not be obtained from the low bidder. A two weeks' inquiry has demonstrated that all which developed at our hearings might easily have been within the knowledge of the members of the board had they been as active in investigation as they were ready to rely solely upon the opinion of others.

This inquiry ran to the proper, conscientious and efficient performance of their official duties, by the members of the Board of Water Supply, from the point of view of business administration in the matter of the award of this important contract.

In view of the foregoing, we deem that our public duty, as Commissioners of Accounts, imposes upon us as such officers the obligation of preferring to you, as Mayor, charges of incompetency and misconduct against the members of the Board of Water Supply. Such formal charges are now in process of preparation and will be filed with you as soon as completed.

The members of the Board of Water Supply were selected by Mayor McClellan from lists submitted to him by three representative New York City organizations of business men: Mr. J. Edward Simmons was named by the New York Chamber of Commerce, Mr. Charles N. Chadwick by the Manufacturers' Association; and Mr. Chas. A. Shaw by the Board of Fire Underwriters. All three are men of large business experience. Prof. Wm. H. Burr and Messrs. P. P. Stearns and John R. Freeman are the Consulting Engineers and Mr. J. Waldo Smith is the Chief Engineer of the Board of Water Supply. All four are members of the American Society of Civil Engineers. Mr. Ernest C. Moore was Engineer for the John Pierce Co. in the preparation of bids and his figures were submitted to Mr. Henry B. Reed, an engineer in the employ of Mr. John B. McDonald, a well-known New York contractor. Mr. Otto H. Klein is Chief Engineer to the Commissioners of Accounts, and the advisory board chosen by the Commissioners for this investigation was composed of Lieut.-Col. Thomas W. Symons, M. Am. Soc. C. E., Halbert P. Gillette, M. Am. Soc. C. E., and Daniel J. Hauer. It may be added that the advisory board was appointed on Oct 29, 1907, visited the site of the proposed reservoir on Oct. 30 and 31 and handed in a report adverse to the award on Nov. 6, 1907.

A POWDER MILL EXPLOSION on Dec. 27 at the Nevecnice Powder Co., at Riverdale, N. J., caused the injury of four men, one of whom will probably die. A similar explosion on Dec. 26 in the works of King's Powder Mills, at Dayton, Ohio, fatally injured two workmen.

A DYNAMITE EXPLOSION at Palermo, Italy, on Dec. 19 was the cause of the death of about 25 persons and the injury of some 100 others. The explosion occurred in a military powder magazine, where a large quantity of dynamite was stored, and it was followed by a number of lesser explosions, the whole town being badly shaken. A fire started almost immediately and added greatly to the ruins and the list of dead.

THE "MAURETANIA" TORE FROM HER MOORINGS at her pier at New York City on Dec. 23, during a wind squall which co-operated with a strong tide in forcing the vessel away from the pier. The "Mauretania" was light, and stood high out of the water, and as the pier shed on the new pier has not yet been built, the wind had a large surface of attack. All the bow lines which held the vessel to the pier broke off the cast-iron bollards to which they were made fast, and swinging by its stern line the boat crushed an ash scow against the adjoining pier.

A VERDICT OF ACQUITTAL was brought in on Dec. 23 in the trial for manslaughter of the crew who were in charge of the train causing the rear collision at Terra Cotta, near Washington, D. C., in which 43 persons were killed on the night of Dec. 30, 1906. (Eng. News, Jan. 10, 1907, p. 50.) The wreck was caused by a special train of empty equipment coaches, en route between Frederick, Md., and Washington, crashing into the rear of a local passenger train which at the time was discharging passengers at Terra Cotta station. It was an extremely foggy night and that fact, coupled with a customary change in blocks at 6:30 p. m.—the accident occurred at 6:31—resulted in a confusion in regard to signals. Although the train crew claimed that a safe signal had been displayed, the signal operator testified to the contrary, and indictments were brought against the engineer, fireman, conductor and brakeman of the special train. It was on these indictments that the above verdict was rendered.

A COMPRESSED-AIR CAISSON in the Metropolitan Tunnel under the Seine at Paris, France, became displaced on Dec. 23, and the outrushing air through the aperture in a head shield hurled five of the workmen against the concrete walls of the tube, killing them instantly. Men in the other sections of the tunnel were panic stricken by the accident, but all succeeded in reaching the open air in safety. This tunnel is being constructed, as described in our issue of April 11, 1907 (p. 409), by a series of horizontal caissons, each of which is floated out on the river and sunk to its place on the river bottom by the weight of concrete which is placed between steel skeleton frames and acts as lining for the completed tube. Each caisson tube is sunk to its proper elevation under the river bottom by the usual caisson working chamber, in which the earth is excavated. It is probable that the blow-out here noted occurred in one of the concrete headings which close each end of the horizontal tubular caissons. The final results of the accident are not yet known, as the river flooded the entire workings and has caused settlements of the earth backing all along the line.

A PECULIAR CHIMNEY ACCIDENT happened in New York City on Saturday, Dec. 14. A gale of wind blew off a section of fresh brickwork at the top of a brick chimney under construction, and the mass dislodged fell through the roof of a building, killing one person. The chimney in question was being built for the New York Steam Co., at 59th St. and East River. It was to be 264 ft. high and 16 ft. diameter inside at the top. The material was perforated radial brick, laid in lime-cement-sand mortar. A firebrick lining extended part way up the chimney. The stack had been carried up to within two or three feet of the top and was being belled out. On Friday, Dec. 13, a section 2 to 2½ ft. high was laid up, which brought the work to within 12 ins. of the cap. Snow and rain on the following morning prevented further work. The wind rose on Saturday from a moderate blow to a very high wind in the afternoon, and the force of the blow razed off practically all the brick laid the day before. The New York office of the Weather Bureau recorded maximum velocities of 56 and 55 miles per hr. between 3 and 5 p. m.; these figures, being for the cup anemometer, correspond to corrected velocities of 45 and 45½ miles per hr. The chimney is about six miles from the Weather Bureau office, however. After the accident the brickwork was taken down for two or three feet before new work was started. The chimney is being built by the M. W. Kellogg Co., 143 Liberty St., New York City.

THE WALNUT LANE CONCRETE BRIDGE at Fairmount Park in Philadelphia, which contains the largest concrete arch span in the world, was the scene of an accident on Dec. 27, which has been so greatly exaggerated in the daily press that it seems proper that a correct and authoritative statement of the incident should be recorded. The Walnut Lane Bridge, as noted in our issues of Jan. 31, 1907, p. 117, and Aug. 15, 1907, p. 168, consists of one large main arch and five small arches each of 53 ft. span. The large arch is in two twin arch rings separated from each other so that they were erected successively by the same width of falsework which was slid over on concrete piers from under one ring which had been completed to the other which was to be built. This centering under the main piers was exceedingly complicated in its arrangement and on account of both its size and the necessity for moving, was very heavy. The centering for the small 53-ft. arches, on the other hand, was of usual construction and in neither design nor size was of particular novelty. However, in removing the centers of one of these small arches, through a breaking of a guy rope or the premature removal of a brace, three of the seven vertical ribs gave way and fell about 15 ft. to the ground, carrying down with them three carpenters, one of whom died from his injuries.

The accident was reported in many papers as having occurred in the falsework of the large arch. This centering, however, had been successfully struck the day before under the second of the twin arches and a deflection of but ⅛-in. noted at the crown and at each quarter point.

FOG WAS THE CAUSE OF TWO SERIOUS RAILWAY wrecks on Dec. 27th. The first occurred at 8.30 a. m. on the Amboy division of the Pennsylvania R. R., at the station at Camden, N. J., and caused the death of three passengers and the injury of 20 others, two of whom may die. The Atlantic City Express had stopped in the elevated yards outside of Camden when the Pemberton local, running at the very slow speed of eight miles an hour, crashed into its rear car. The forward train was not harmed but the locomotive on the local backed upon its train and the tender completely telescoped the first car, a light passenger coach used as a smoking car, in which all those injured were riding. The express had a flagman some distance in its rear, but the heavy fog rising from the nearby Delaware River prevented his signal being seen.

The second accident occurred about 7 p. m., when a heavy Grand Trunk passenger train, speeding at the rate of 40 miles an hour, came into head-on collision with a double-header freight train, waiting on a switch about 1½ miles north of Lenox, Mich. Five trainmen were killed and one more is expected to die; no passengers were killed or injured. The freight had switched from the main track to a siding to allow the passenger to pass and it is supposed that the switch was not fully closed. On account of the very heavy fog prevailing the crew on the passenger locomotive could not see the signal set against them.

FOUR CARS OF A PASSENGER TRAIN were blown from the track in a heavy gale near Marshall, Colo., on Dec. 24. No one was seriously injured.

BIDS FOR A GARBAGE REDUCTION PLANT are to be received by the Board of Public Service of Columbus, Ohio, until Jan. 14, 1908. The proposals must include the design and construction of works to heat both garbage and dead animals. The works will be located in Franklin Township, Ohio, directly south of the sewage disposal works now under construction by the city and about four miles south of the Ohio State Capitol. Drawings and specifications may be obtained from Mr. Henry Maetzel, Chief Engineer of the Department of Public Service, Columbus, Ohio. The works must have a capacity of 100 tons per 24 hrs., with buildings large enough and so planned that equipment of an additional capacity of 50 tons may be installed. The plant must be so designed and built that neither the material treated nor its products shall be exposed to the atmosphere from the time it is placed in the digestors,

until rendered non-putressible and containing less than 10% of moisture. The gases emitted, as well as air passing over heated materials, shall be discharged through the furnaces, and all water washed shall be evaporated.

The specifications call for buildings without wood, to be composed chiefly of concrete and brick, but with a choice between (1) a flat reinforced-concrete roof, covered with either slag, gravel or vitrified tile laid in asphalt, and (2) a steel framework covered with slate nailed onto terra cotta. On completion, the plant is to be operated by the contractor, at the expense of the city, for 60 days, and, apparently during this period, individual parts of the equipment are to be tested and also the plant as a whole, the latter to determine whether the guaranteed cost of operating the plant has been attained. This cost is to be measured in man-hours and in fuel-pounds per ton of garbage treated.

A HYDRO-ELECTRIC POWER PLANT on the Sacandaga River, including a storage dam, power dam and power plant, and in addition electric transmission lines to Saratoga, Ballston, Mechanicville, Troy, Albany, Watervliet, Schenectady and Amsterdam, to be built by the Hudson River Electric Power Co., have been approved by the New York State Public Service Commission, Second District. The approval is conditioned on the State having authority to buy the proposed storage dam, near Conklingville, N. Y., within 3½ years at actual cost to the company, and also on the company filing with the commission statements as to the manner and proceeds of the sale of the $3,000,000 of bonds authorized by the commission, and also detailed half-yearly statements of the expenditure of the proceeds of the sale of the bonds. These provisions were inserted at the instance, or at least partly on that account, of the State Water Supply Commission, which is considering a large water storage project on the Sacandaga River.

THE BRONX SEWER CONTRACT AWARD, under which a trunk sewer to serve White Plains and other suburbs of New York City was to be built by the Mack Paving & Contracting Co., of Philadelphia, for $1,817,950, has been taken into the courts. The alleged basis of this action, which is by a taxpayer's application for injunction, is that money would have been saved by awarding a number of section contracts instead of a single contract. It is said, how truly we do not know, that the suit is backed, as have been several previous but unsuccesssful suits in this same general matter, by anti-pollution agitators connected with the Merchants' Association of New York City. The sewer, if built, would discharge into the Hudson River, near the line between Yonkers and New York City.

PRECIPITATING AND COAGULATION BASINS are to be used as a preparatory treatment in connection with the slow-sand filters of the Indianapolis Water Co. A chemical mixing station adjoining the present laboratory will be built, at which lime and sulphate of iron, when required, will be admitted to a 66-in. reinforced-concrete pipe leading some 840 ft. to the first precipitating basin. There will be four basins, each about 4 acres in area and having a water depth of 8½ ft. at the start and 11½ ft. ultimately. The basins are to be operated on the continuous plan. Construction was begun last August. The water treated is taken from a canal, which diverts a portion of the flow of White River at Broad Ripple, some 5 or 6 miles above the city. There will be a gravity flow through the basins and filters. Mr. H. E. Jordan is Chemist and Bacteriologist of the Indianapolis Water Co.; Mr. William Curtis Mabee is Constructing Engineer, and Mr. George W. Fuller, M. Am. Soc. C. E., of Hering & Fuller, New York City, is Consulting Engineer.

THE SIDES OF THE CULEBRA CUT on the Panama Canal are to be cut smooth by stone channeling machines. The Canal Commission has purchased 24 Sullivan channelers of the largest size, and will put them in use at Culebra when the lower part of the excavation is undertaken. The only previous use of channeling machines on a scale approaching this was on the Chicago drainage canal, where channelers were also used in the rock sections.

THE PANAMA CANAL plans are to be altered by the extension of the sea-level section at the Pacific end four miles further inland, and the location of the westernmost locks and dam at Miraflores instead of La Boca. Dispatches to the New York "Tribune," dated Dec. 27, state that Col. Goethals recommended this change, as bet-

ter foundations are found at Miraflores than at La Boca. This change will greatly reduce the size of Lake Sosa, which is to be at an elevation of 55 ft. above sea level. It will now extend from the end of the summit level at the foot of the Pedro Miguel lock to the dam at Miraflores, a distance of about two miles; and will be only half a mile or less in width. It may be noted that the location of the Pacific locks at Miraflores where they would be safe from possible bombardment by a hostile fleet was advocated by Secretary Taft, in a report published in our issue of Feb. 22, 1906.

STEEL SHAFT LINING IN QUICKSAND is being used for the foundation work of the new plant being built at Crystal City, Mo., for the Pittsburg Plate Glass Company. There will be eight shafts or pits, 22 × 26 ft., and about 40 ft. deep. The excavation is in clay, except for a quicksand stratum about 20 ft. below the surface. Work on the first shaft was commenced with wooden sheeting and the usual form of timbering, but it progressed very slowly, and it was decided to use the Nye steel sheet piling, consisting of 15-in. steel channels locked together. This was driven in 40-ft. lengths, and proved practically watertight. In order to brace the sheeting, two rows of waling were put in, each wale consisting of a steel I-beam.

PERSONAL.

Mr. Max Feldman has been appointed Assistant Engineer in the Bureau of Buildings, Borough of Manhattan, New York City.

Mr. W. P. Chrysler has been appointed Superintendent of Motive Power of the Chicago Great Western Ry., vice Mr. J. E. Chisholm, resigned.

Mr. E. McCabe has been appointed Supervisor of Bridges and Buildings on the Boston & Albany R. R., with headquarters at Springfield, Mass.

Mr. George W. Dickson, late Master Mechanic of the Chicago, Indianapolis & Louisville Ry., has accepted a similar position on the Grand Trunk Ry.

Mr. George Reyer, recently Superintendent of Water-Works in Mt. Vernon, N. Y., has accepted the position of Superintendent of Water-Works at Nashville, Tenn.

Mr. H. F. Sanville, Assoc. Am. Inst. E. E., has severed his connection with Dodge & Day, Engineers, of Philadelphia, to join the organization of Mr. F. B. Gilbreth, General Contractors.

Mr. A. J. Lederle, Jr., and the firm of Messrs. Chambers and Hone, all of New York, have been appointed appraisers in proceedings to municipalize the plant of the Briarcliff Water Co. at Briarcliff, N. Y.

Mr. William Cotter, lately General Manager of the Pere Marquette R. R., has been elected President of that road, which recently has been taken from the hands of a receiver and turned over to the new organization.

Mr. Charles E. Sargent, M. Am. Soc. M. E., who has been for some time Manager of the Sargent Engineering Co. of Chicago, has resigned to become Chief Engineer and Manager of the Gas Engine Department of the Wisconsin Engine Co. of Corliss, Wis. Mr. C. E. Beck will succeed Mr. Sargent in the Sargent Engineering Co.

Rear-Admiral W. H. Brownson, U. S. N., Chief of the Bureau of Navigation, has resigned, the same to take effect immediately, and Commander Cameron McR. Winslow has been appointed as his successor. Rear-Admiral Brownson had retired some time ago from the duty of the regular line officer and was holding his last position as a purely executive officer.

Capt. Clark S. Smith, Corps of Engineers, U. S. A., has succeeded Capt. G. M. Hoffman, U. S. A., in charge of the Third Mississippi River District extending from the mouth of White River to Warrenton, Miss., and also in charge of the Southwestern District, with headquarters at Vicksburg. As previously announced in this column, Capt. Hoffman has been detailed to Panama.

Obituary.

John P. Spindle, Assistant Engineer in Charge of one of the parties on the preliminary surveys for the Panama Canal, died at his home in Washington, D. C., on Dec. 20, aged 46 years.

Harrison Loring, who started in 1857 one of the first plants for the erection of iron ships, died at his home in Boston on Dec. 26, at the age of 85 years. Mr. Loring's firm built the monitor "Canonicus," which was used in the Civil War and as late as 1890 built the U. S. S. "Marblehead" which was in the battle of Manila Bay, in 1898.

Richard M. Berrian, M. Am. Soc. C. E., died Dec. 23, 1907, at his home in Hingham, Mass. Mr. Berrian was for 17 years an Assistant Engineer of Construction of the N. Y., N. H. & H. R. R., having charge of many of the Harlem River improvements of that road. More recently he had been Engineer in Charge of the Fall River Bridge which was constructed by the State of Massachusetts.

Coleman Sellers, one of the most noted mechanical engineers of America, died at his home in Philadelphia on Dec. 28, aged 81 years. He was born in Philadelphia on Jan. 28, 1827, and was educated in the public schools and private academies of that city. Although at first destined for an agricultural life, his conspicuous ability in designing various mechanical appliances on the farm led his two older brothers to employ him as draftsman in their Globe Rolling Mills at Cincinnati, where he rose to be manager and general superintendent. In 1851 he became foreman for Niles & Co., locomotive builders in Cincinnati and in 1856 returned to Philadelphia to take charge of the drafting room of Wm. Sellers & Co., manufacturers of machinery and machinery tools. In this firm, the head of which was his cousin, he remained for 30 years, becoming chief engineer and a partner. He retired from active commercial business in 1886, devoting the last 20 years of his life to private practice as a consulting engineer. In 1881 he was appointed Professor of Mechanics at Franklin Institute and in 1888, non-resident member of the faculty of Stevens Institute of Technology.

Throughout his life Dr. Sellers was interested in many matters of a scientific nature outside of the more restricted confines of his professional work. Particularly did he interest himself in photography, in the modern development of which he played a prominent part. So early as 1861 he patented a moving picture machine which, in a crude way, bore marked resemblance to the modern apparatus. In 1890 he represented America on the International Niagara Commission of five members, which was organized to consider the practicability of utilizing the water power at Niagara for the generation of electric current. He afterwards acted as consulting engineer for the Cataract Construction Co., as Chief Engineer for the Niagara Falls Power Co. and as Chief Mechanical Engineer for the Canadian Niagara Power Co.

He was a charter member and past-president of the American Society of Mechanical Engineers and a member of nearly every national or international technical society of note. In 1876 he was decorated by the King of Norway and Sweden with the Royal Norwegian Order of St. Olaf; in 1888 Stevens Institute conferred upon him the degree of Doctor of Engineering and in 1899 the University of Pennsylvania made him a Doctor of Science.

ENGINEERING SOCIETIES.

COMING MEETINGS.

MICHIGAN ENGINEERING SOCIETY.
Jan. 7-8. Annual meeting at Battle Creek, Mich. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 8. Annual Meeting at Boston, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

IOWA ENGINEERING SOCIETY.
Jan. 8-9. Annual meeting at Des Moines. Secy., A. H. Ford Iowa City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 15. Annual meeting at New York City. Secy., Chas. Warren Hunt, 220 West 57th St., New York City.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 15-17. Annual meeting at Champaign, Ill. (University of Illinois). Secy., E. E. R. Tratman, 1636 Monadnock Block, Chicago.

INDIANA ENGINEERING SOCIETY.
Jan. 16-18. Annual meeting at Indianapolis. Secy., Charles C. Brown, 408 Commercial Club Building, Indianapolis.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 20-25. Fourth annual convention at Buffalo. President, Richard L. Humphrey, 1001 Harrison Bldg., Philadelphia, Pa. Convention Manager, Dal H. Lewis, 760 Main St., Buffalo.

WOOD PRESERVERS' ASSOCIATION.
Jan. 21. Fourth annual meeting at Kansas City. Secy., C. W. Berry, Laramie, Wyo.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 21-23. Annual meeting at New York, Engineering Societies Building, 29 West 39th St. Secy., W. M. Mackay, 29 West 39th St., New York.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Jan. 23-25. Annual meeting at Chicago. Secy., C. R. Richards, Columbia University, N. Y.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28-30. Annual meeting at Montreal. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal.

OHIO ENGINEERING SOCIETY.
Feb. 11-13. Annual meeting at Columbus. Secy., E. G. Bradbury, 85 North High St., Columbus.

WASHINGTON SOCIETY OF ENGINEERS.—At the regular annual meeting of the society held on Dec. 17, 1907, the following officers were elected: Pres., A. P. Davis; Vice-Pres., D. S. Carll; Secy., J. C. Hoyt; Treas., J. F. Hayford.

OKLAHOMA ENGINEERING SOCIETY.—This society, which changed its name upon the accession of Oklahoma to statehood from the Oklahoma Engineer's and Surveyor's Society, held its first annual meeting in Oklahoma City on Dec. 27 and 28, 1907.

NEW ENGLAND WATER-WORKS ASSOCIATION.—At the annual meeting of the association, to be held in Boston on Jan. 8, papers will be read by Mr. Harry L. Thomas on "Experience with a Producer-Gas Plant" and by Mr. Freeland Howe, Jr., on "Action of Water on Water Pipes."

CENTRAL RAILWAY CLUB.—The annual meeting will be held at the Transportation Club in Buffalo, N. Y., on the evening of Jan. 10, 1908. Mr. D. C. Bull will read a paper on "Some Joint Problems of the Mechanical and Operating Departments." The business meeting will be followed by a banquet at the Ellicott Club.

UNDERWRITERS' ELECTRIC ASSOCIATION.—The annual meeting of the Electrical Committee of the Underwriters' Electric Association is to be held in March, 1908, in New York City. Date and place will be announced later. The present requirements of the National Electrical Code will be the principal subjects to be considered, and it is requested that any changes and additions desired be forwarded to Mr. C. W. Goddard, Secretary, 55 Kilby St., Boston, Mass., before Feb. 1, that parties interested may have ample opportunity to consider them in advance of the March meeting. It is stated that this meeting will be open, and that all interested are invited and requested to be present.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION.—The following list of subjects has been prepared for the convention to be held at Milwaukee, Wis., in November, 1908: (1) How to reduce stock claims, fire claims and injuries to employees. (2) Organization of the roadmasters' division, from office to trackwalker. (3) Substitutes for wooden ties, recommendations and cost. (4) Relaying rails, organization of forces, methods of working and cost. (5) Care of track tools and materials. (6) Is it advisable to dress off ballast to a shoulder beyond the end of the tie. (7) Paving of ditches. (8) How to drain the midway of double track; whether by surface ditches or by tile drains. (9) Should the gage of curves be readjusted for wear to the side of the rail head, and by moving which rail. There will also be papers by Mr. F. A. Smith, and by Mr. E. E. R. Tratman, Associate Editor of Engineering News.

MACHINERY CLUB OF THE CITY OF NEW YORK.—For the purpose of providing a pleasant meeting place for entertainment in the heart of the business section of Manhattan Island, various members of the machinery and metal trades having their headquarters in New York, have organized the above club and have engaged the greater part of two of the upper floors of the new Hudson Terminals Building on Fulton and Church Sts. This building has already been made the center of the metal trade district and many of the firms engaged in this industry are preparing to move into it on its completion next May. As it is the Manhattan terminal to the lower Hudson River tunnels its position is peculiarly well adapted for any business man whose work to a great extent depends upon visiting buyers. The location of the new club rooms is therefore particularly advantageous. The Secretary of the Club is Mr. Theodore Waters, 26 Cortlandt St., N. Y.

THE NATIONAL ASSOCIATION OF CEMENT USERS will hold its fourth annual convention in Buffalo from Jan. 20 to 25, 1908. This convention, like others in the past, is to be in two parts, the exhibit, which will be held in the old Sixty-fifth Armory, and the technical proceedings, which will be held in the Teck Theater Building. The exhibition is expected to be the largest ever held in the interests of the concrete and cement trades, and as the floor space—larger than in any previous similar exhibit—is about all contracted for, there is small doubt that the show will be immensely successful. The papers to be presented have been carefully arranged with a view toward treating phases of the concrete question which are still matters of discussion, the solution of which would add much toward perfecting the industry. The technical meetings are to be held on Tuesday, Wednesday, Thursday and Friday, mornings and evenings, the afternoons of each day and all of Monday and Saturday to be left open for the exhibition. A partial list of the papers follows:

Cement Sidewalks; C. W. Boynton, Chicago.

Elementary Mechanics of Reinforced Concrete; Prof. W. H. Hatt, Purdue University.

Factory Built Concrete; W. H. Mason, Stewartsville, N. J.

The Necessity for Continuity in the Steel Reinforcement of Concrete Structures; a discussion.

Concrete as a Plastic Material for the Expression of Architectural Ideals; I. K. Pond, Chicago.

Treatment of Concrete Surfaces; a discussion.

Artistic Effects in Reinforced Concrete; R. F. Tucker, New York.

Architectural Concrete in Landscape Work; a discussion.

Waterproofing Cement Structures; a discussion.

Practical Methods in the Erection of a Reinforced Concrete Building; H. H. Fox, New York.

The Unit vs. the Loose Bar System of Reinforced Concrete Construction; E. G. Perrot, Philadelphia.

In addition there are many reports of the various standing and special committees.